

How does Congestion-Induced Commuting Time affect a Worker’s Time Allocation between Labour and Leisure?

How congestion-induced commuting time affects a worker’s time allocation between labour and leisure

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Abstract

Urban workers lose scarce time to congestion every day, but most studies focus on its monetary or productivity costs. This paper asks how congestion-induced commuting time changes a worker’s allocation between labour and leisure. A theoretical model divides the worker’s available time among work, leisure and commuting, then maximises utility under flexible- and fixed-hour arrangements. For flexible-hour workers, additional congestion reduces both optimal work and leisure time, lowering income and utility. For fixed-hour workers, paid hours remain unchanged, but leisure falls and earnings are spread over more total time committed to work. The model therefore treats congestion as a binding time constraint and shows that its burden depends on the worker’s employment arrangement.

Introduction

Commuting uses time that could otherwise go to work or leisure. Congestion makes the journey longer and tightens the worker’s daily time constraint.

Why congestion matters

60–90 min

Mumbai: average daily commute

peak speeds below 20 km/h [1]

ERP + COE

Singapore: congestion actively managed

road pricing, vehicle quotas [2][3]

Research question: How does congestion-induced commuting time affect a worker’s time allocation between labour and leisure?

Research gap: existing studies mostly measure congestion through monetary costs or productivity losses [4]–[7]. This study instead models congestion as a limit on how workers split scarce time between labour and leisure.

Methods

A theoretical optimisation model for one representative worker. No survey or experimental data were collected.



- 1 Time constraint: $T = h + l + c$ (T = available time, h = labour, l = leisure, c = commuting time lost to congestion)
- 2 Income: $y = wh$ (w = hourly wage)
- 3 Utility: $U = y^\alpha l^{1-\alpha}$ (a measure of the worker’s preference for income and leisure; $0 < \alpha < 1$ is the weight on income)
- 4 Flexible hours: use calculus to choose the h that maximises U , subject to the time constraint
- 5 Fixed hours: set labour at a fixed H , then find how a rise in c changes leisure and effective hourly earnings

Results

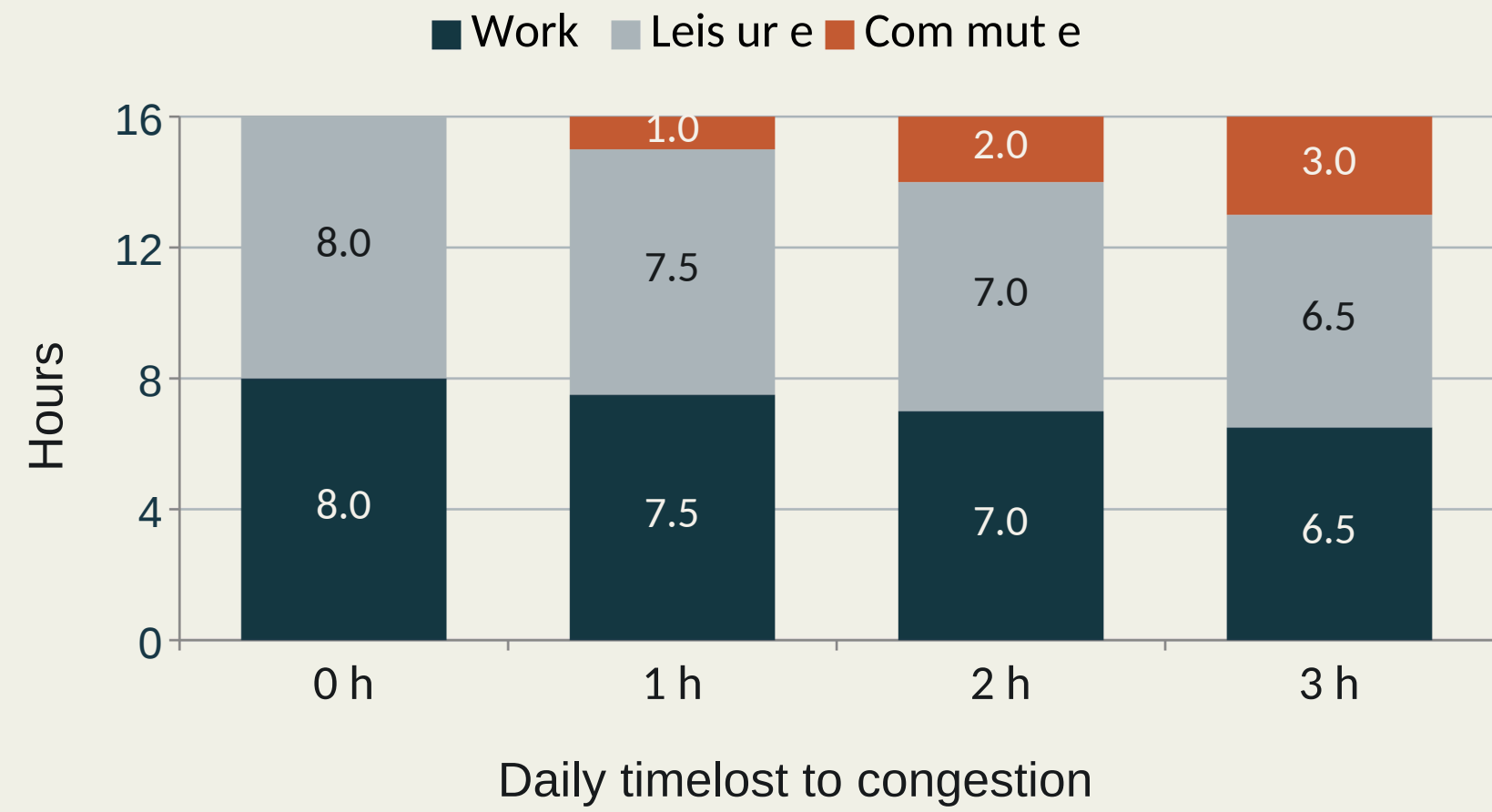
$$h^* = \alpha(T - c) \quad l^* = (1 - \alpha)(T - c)$$

One extra hour of congestion reduces work by α hours and leisure by $(1 - \alpha)$ hours.

$$\partial h^* / \partial c = -\alpha \quad \partial l^* / \partial c = -(1 - \alpha)$$

The worker keeps the same preferred proportions of work and leisure, but congestion reduces the total time available to both.

Flexible hours:workandleisurebothfall

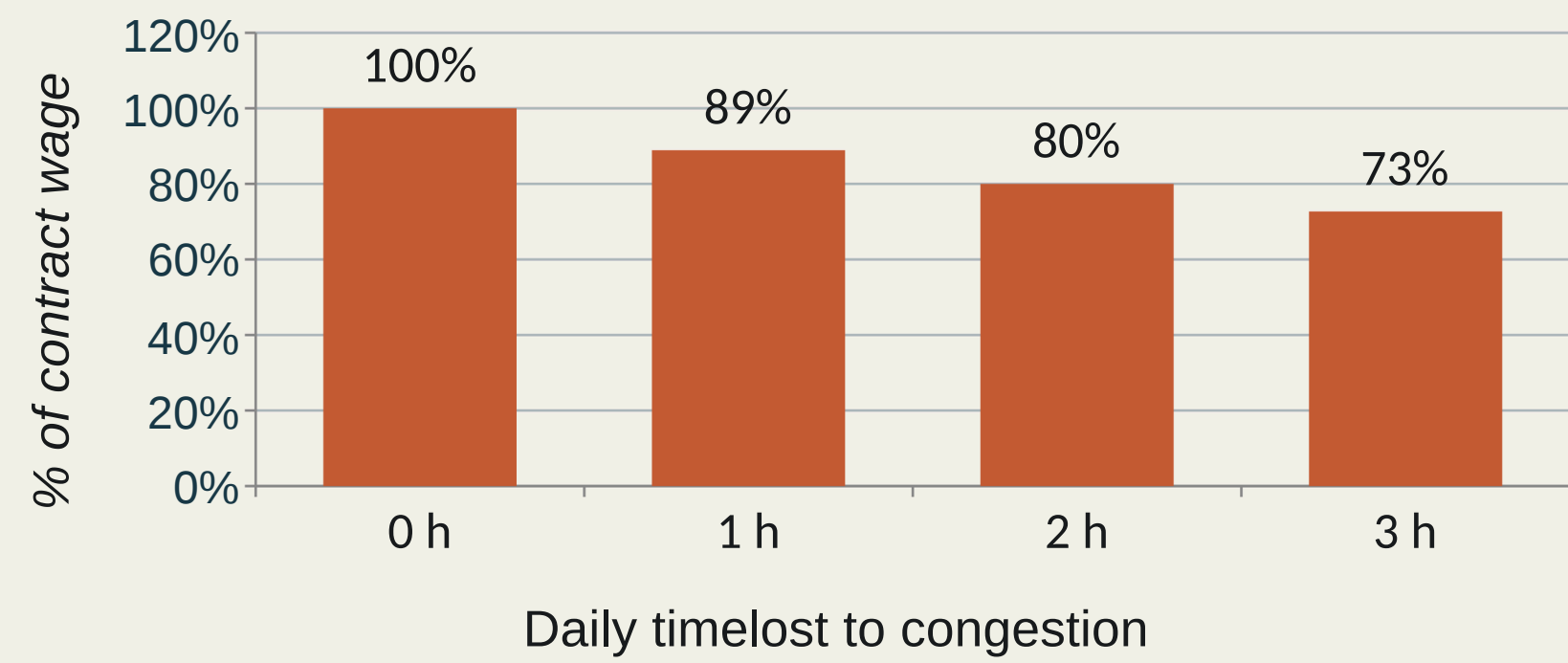


Illustrative scenario, not empirical data: 16 waking hours, $\alpha = 0.5$

Fixedhours:the effective hourly wage falls

$$w = wH / (H + c)$$

Effectivehourlywage = total earnings ÷ total work-and-commute time



Illustrative scenario: 8-hour contract. The contractual wage is unchanged, but each hour committed to the job earns less.

Discussion

A different view of congestion. Earlier studies mainly measure congestion through wage, productivity or monetary costs [4]–[7]. This model adds to that work by treating congestion as a direct limit on workers’ scarce time.

How this differs from prior work. Mun and Yonekawa model congestion mainly through its monetary cost [6]. Here it enters the time constraint, so its effects on labour and leisure can be seen separately.

Employment structure matters. Flexible-hour workers give up both labour and leisure, while fixed-hour workers protect paid hours and lose leisure instead.

Preferences shape the response. α sets how the remaining time is divided. Congestion does not change the preferred split, only the time available.

Limitations. One representative worker, fixed wages and preferences, congestion taken as given, and no fatigue or economy-wide effects.

Conclusion

Main finding: congestion acts as a binding time constraint. Depending on employment arrangements, it can reduce workers’ income, leisure, or both.

Policy implication: reducing congestion can return scarce time to workers, a benefit that monetary cost estimates may not fully capture. Singapore’s policies are one example [2].

Future research: test the model with Mumbai commuting data, let wages and preferences vary across workers, and include fatigue from longer journeys.

References

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THE BIG IDEA

Preferences decide how workers split their time.

Congestion decides how much time is left to split.