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ON THE COMPRESSED WORK SCHEDULE IN TRAVEL DEMAND MANAGEMENT

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Compressed work schedule (CW) is one of the widely adopted flexible work arrangements. Literature shows that CW can significantly reduce commuting trips per pay period and thereby relieve peak hour congestion. Without policy intervention, how many firms will choose CW? Is it socially beneficial to encourage all commuters to switch to CW? This paper mainly addresses these questions. The weekly/monthly commute problem is investigated with bottleneck congestion in the presence of CW. The effects of CW on urban productivity and activity utility are incorporated in our model as well. At equilibrium, no firms or commuters can benefit by unilaterally switching their schedule type or changing their daily commute pattern. The equilibrium conditions are demonstrated in which some firms adopt CW. By altering some commuters' work schedule, CW not only reduces weekly/monthly commute demand but also separate their daily departures. Moreover, the social surplus is calculated as the total net benefit. The comparison shows that the optimum points do not necessarily coincide with the equilibrium points.

Keywords: Flexible work arrangement, Compressed work schedule, Bottleneck congestion, Production effects.

1 Introduction

Compressed work schedule (CW) is a flexible work arrangement. Instead of working in standard workdays, CW allows employees to reallocate the same number of work hours per pay period to fewer days and to enjoy more days off for leisure. One of the most well-known types of CW is the 4/40 schedule, where the employee works four 10-hour days and have one extra day off while the total number of weekly working hours remains unchanged. Such an idea has been advocated since the 1970s and has been adopted by some firms as it is an easy-to-implement alternative working schedule which can benefit both the employers and employees (Fottler, 1977; Ronen & Primps, 1981; Hung, 1994).

One significant but often overlooked advantage is that total commute trips decrease with the implementation of CW. Hung (1996) provides some demonstrations on how CW can reduce work commuting. Apparently, the additional days off in CW directly lower the commute demand and thereby relieve traffic congestion in some weekdays. For instance, in an extreme case when all commuters work four days a week instead of five days, one-fifth of the commute trips disappear. In other words, commute related congestion fall by one-fifth, so as the related vehicle emission. Further, since the extended hours during work days usually signify commute outside peak hours, daily travel cost to and from work for employees adopting CW can be reduced. Peak congestion can thus be flattened. CW has considerable potential to be a practical measure in travel demand management (TDM) to alleviate traffic congestion (Sundo & Fujii, 2005).

Admittedly, whether to adopt CW or not depends not only on commute expense but also productivity effect and work-family conflict. While some research showed that individual performance improves in CW due to the increased job satisfaction (Foster et al., 1979; Golden, 2012), some argued that employee's efficiency decrease in the extended hours as a result of fatigue (Goodale & Aagaard, 1975). Regarding economic agglomeration, such alternative working schedule staggers the working hours of employees. Thereby the less agglomerated work hours lead to the lower instantaneous productivity of each employee. Work and family balance is another concern. CW can affect the utility of non-work activity in two ways. On the one hand, CW brings greater flexibility to employees (e.g., extended weekend) to manage work and household activity (Gannon, 1974). On the contrary, longer hours of work per day deprive employees of time for daily off-work recreation. Employers and employees must make trade-offs. The number of employees adopting CW can affect the daily departure pattern of commuters and the individual output per pay period, and in turn, the commute pattern and productivity can affect employees' choices on work schedule (Kitamura et al., 1997).

However, few studies have linked CW to TDM, and most of them are empirical studies. More specifically, the number of firms adopting CW at equilibrium and whether there is an optimum maximizing social welfare remain unknown. Thus this paper focuses on addressing these problems.

In fact, besides CW, there are some other types of flexible work arrangements (Breaugh, 1983; Dunham et al., 1987; Baltes et al., 1999), including flextime, staggered work hours, etc. A few analytical models have been developed to study these flexible work arrangements. One seminal work is done by Henderson (1981). Incorporating the production effect, he presented an analytical approach about the staggered work hours where work start times of different firms are different. It was shown that work start times are distributed continuously at equilibrium. Takayama (2015) used the potential function to revisit the staggered work hours model. Mun and Yonekawa (2006) focused on the flextime where employees can choose their work start time freely. He tried to figure out the equilibrium and an optimum number of firms using flextime and found that multiple equilibria arise in some cases. In the case of CW, however, little similar analytical work has been carried out.

Our work thus emphasizes the commute pattern considering CW with its effect on productivity, congestion and activity utility. We aim at examining how CW influences employees' travel behavior and work performance and in turn how these factors influence employer's affection towards CW. By investigating the intrinsic interrelationship between CW and its resulting commute pattern, the potential of CW in being a useful TDM measure can be better understood. It is also hoped that this paper can provide revealing insight to transportation planners on how to plan and formulate CW. More practical guidelines of CW are given to employers in future implementation as well.

The rest of the paper is organized as follows. First, the model framework is presented incorporating the production effect, congestion effect and activity utility. The individual net utility, which is defined as the output minus activity cost and commute cost, determines employers' and employees' decision on whether to adopt CW. Then the equilibrium commuting pattern is examined. Next, the optimal number of firms adopting CW to maximize total net benefit is studied and compared to the equilibrium solutions. Finally, we wrap up the paper with some concluding remarks and future research directions.

2 Introduction

2.1 *Basic setting*

Consider a city with a CBD and a residential area connected by a highway with a single bottleneck. During workdays, commuters travel from home to workplace in CBD in the morning and from workplace back home in the evening. For each pay period (one week/ one month), the total hours of work of each worker are fixed and given. Let N^N and N^C denote the number of commuters following normal and compressed work schedules respectively. The total number of commuters, $N = N^N + N^C$, is assumed to be given.

For employers, whether to adopt CW depends on the workers' productivity and the corresponding wage expenses. All firms aim at maximizing their profit per worker, which is defined as

$$\pi_i = F_i - w_i, \tag{1}$$

where F and w is the output and wage per worker per pay period respectively and $i(= \mathrm{N}, \mathrm{C})$ indicates the adopted work schedule (N represents normal schedule, C represents CW).

For employees, whether to work in a firm adopting CW depends on the net income, and each worker seeks to maximize it, which is defined as

$$u_i = w_i - P_i - A_i, \tag{2}$$

where P and A represent the individual commute cost and activity cost per pay period respectively.

We further assume that firms produce homogeneous goods under perfect competition and employees with identical skills can switch firms freely. Therefore, at equilibrium, no employee can increase his net income by changing the type of companies at which he is employed unilaterally. For each pay period, the daily commute patterns on the days when all workers work and when CW workers have days off remain consistent, respectively. Also, all firms are price takers with zero profit at equilibrium, and they have no incentive to alter their work schedule arrangement. That is

$$\pi_N = \pi_C = 0, \implies F_N = w_N, F_C = w_C \tag{3}$$

$$u_N = u_C, \tag{4}$$

Thus, there is

$$\Delta_N = F_N - P_N - A_N = F_C - P_C - A_C = \Delta_C \tag{5}$$

at equilibrium, where Δ_i denotes the individual net benefit of commuters.

Assume the CW schedule is the same for all firms adopting it. Conventionally, employees with normal working hours work for H hours per day and m days per pay period. Now with

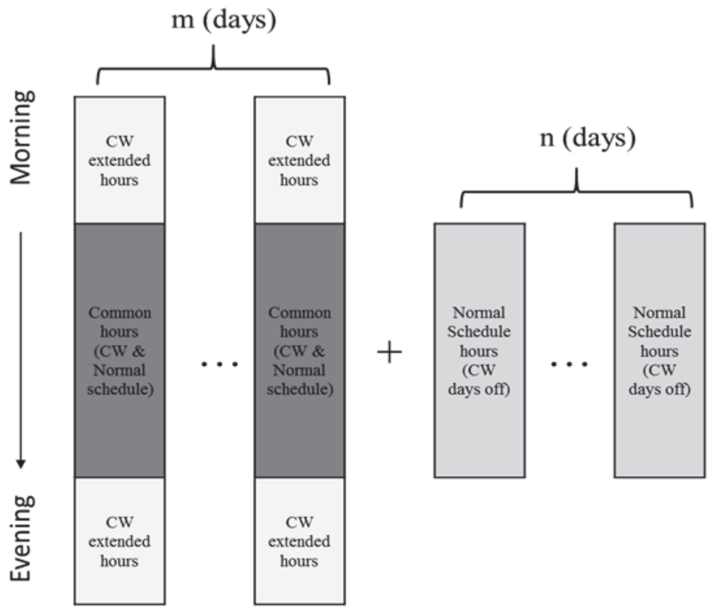

Figure 1 Normal and CW work schedule per pay period.

compressed work schedule, some employees work ΔH extended hours per workday for the benefit of n fewer workdays. Visibly, since total individual working hours are fixed, there is $H \cdot m = (\Delta H + H) \cdot (m - n)$, i.e. $\Delta H = \frac{Hn}{m-n}$. We further assume $m > 2n$, i.e. $m - n > n$, so that in each pay period workdays are still more than the extra off-work days even adopting CW. The extended hours ΔH is assumed to be allocated to before-work and after-work periods symmetrically. Namely, workers following CW schedule start work $\frac{\Delta H}{2}$ hours earlier than the normal work start time in the morning and finish work $\frac{\Delta H}{2}$ hours later than the normal work finish time. The normal and CW work schedule per pay period is shown in Figure 1.

2.2 *Production effect*

Literature showed that production per worker is proportional to working hours within a certain threshold, beyond which the output efficiency diminishes (Pencavel, 2015). It also stated that such threshold varies across types of work and workers. Thus in this model, the lengths of daily working hours in both schedules are assumed to be within the threshold of linearity, so that the output per worker at time t at day d is independent of daily working hours and is assumed to be linearly increasing with the number of workers on duty $NN^d(t)$ in all firms at that moment t considering the agglomeration effect (Takayama, 2015), that is

$$f_i^d(t) = \kappa \cdot NN^d(t) \tag{6}$$

where $\kappa > 0$ is a constant parameter. For simplicity, the maximum unit time individual productivity is normalized as one. In our case, when all commuters are on duty, i.e. $NN^d(t) = N$, the instantaneous output $f_i^d(t)$ reaches maximum equal to 1, thus let $\kappa = \frac{1}{N}$ hereinafter. The individual outputs per pay period for workers with normal and CW schedules are then given as follows.

$$F_N = \sum_{d=1}^{m} \int_{t}^{t+H} f_N(t)\,\mathrm{d}t = \kappa \cdot (n \cdot H \cdot N^N) + (m-n) \cdot H \\ = \frac{1}{N} \cdot (n \cdot H \cdot N^N) + (m-n) \cdot H, \tag{7}$$

$$F_C = \sum_{d=1}^{m-n} \int_{t}^{t+H+\Delta H} f_C(t)\,\mathrm{d}t = \kappa \cdot (m-n) \cdot (H \cdot N + \Delta H \cdot N^C) \\ = \frac{1}{N} \cdot (n \cdot H \cdot N^c) + (m-n) \cdot H \tag{8}$$

2.3 *Commute cost and activity cost*

The adopted work schedule affects periodic commute demand as well as the daily departure pattern. The normal schedule workers have m days' to and from work commute trips, while CW workers have only $m-n$ days' trips. As for the daily departure patterns, the bottleneck model (Vickrey, 1969) is applied to better investigate the dynamics of congestion effect resulting from the two types of work schedule. It is also assumed that the bottleneck with capacity s follows FIFO and the CBD area is abstracted as a point with all firms located at that point. Without loss of generality, free-flow travel time is assumed to be zero.

Over the course of morning peak, homogeneous commuters with the same value of time α travel from home to workplace. Two groups of workers must arrive at workplace before the two-predetermined work start times and no late arrival is allowed. The value of time is the monetary amount one employer would be willing to pay to reduce travel time, which can be considered as unit time income. In our setting, as the individual wage equals to individual output at equilibrium and the maximum unit time output is normalized to 1, there is $\alpha \leq 1$, where the equality sign holds if and only if no employer adopts CW. The schedule penalty for a unit time of early arrival β is then assumed to be less than α (i.e. $1 \geq \alpha > \beta > 0$) (Small, 1982). Given the CW work hours are symmetrical about the midpoint of the normal work hours, the commute patterns of morning and evening peak are symmetrical. Therefore, only the morning peak is examined in what follows.

Regarding activity cost, the individual initial activity utility per pay period U is assumed to be sufficiently large and there are only two time periods everyday inducing activity cost. One is the normal off-work hours when workers adopting normal schedule don't need to work, including the commute time and the daily extended hours of CW employees. These are the hours when workers are deprived of daily off-work recreation. The other is the normal working hours when all normal schedule employees work during that period. These are the hours when workers usually work and are expected to have fewer household activities. Therefore, the unit time activity costs for these two periods (denoted by ϵ_1, ϵ_2 respectively) are further assumed to be given and time independent with $\epsilon_1 > \epsilon_2$. We postulate this condition based on the assumption that the activity cost is higher during early morning or late night than that during daytime working hours (Arnott et al., 2005).The time durations of workers bearing activity cost under both work schedules are calculated as the average time that group of commuters spending on it, respectively. Thus, the net individual activity cost per pay period under both work schedules become

$$A_N = -U + 2 \cdot \epsilon_1 \cdot \overline{T_N} \cdot m + \epsilon_2 \cdot H \cdot m, \tag{9}$$

$$A_C = -U + 2 \cdot \epsilon_1 \cdot (\frac{\Delta H}{2} + \overline{T_C}) \cdot (m-n) + \epsilon_2 \cdot H \cdot (m-n) \tag{10}$$

where $\overline{T_N}, \overline{T_C}$ represent the average earliness of workers in each schedule from home departure time to their assigned work start time during morning peak. Then the first parts in (9) (10) denote the initial activity cost, the second parts denote the off-work's activity cost including morning and evening commute and the extended hours of CW workers, and the third parts denote the normal working hours' activity cost.

Since one's equilibrium activity cost is independent of his/her departure time in our setting, the departure rate from home $r = \frac{s\alpha}{(\alpha-\beta)} > s$, is independent of the activity cost. Let $s_1 = \frac{2(m-n)N^N}{H\cdot n}$, the cumulative equilibrium commute costs per pay period of both normal and CW schedule are then given as

$$P_N = \begin{cases} \dfrac{2m\beta}{s}\cdot N^N & s \geq s_1 \\ \dfrac{2n\beta}{s}\cdot N^N + \dfrac{2(m-n)\beta}{s}\cdot N & s \leq s_1 \end{cases} \tag{11}$$

$$P_C = \begin{cases} \dfrac{2(m-n)\beta}{s}\cdot N^C & s \geq s_1 \\ \dfrac{2(m-n)\beta}{s}\cdot N - 2Hn\beta & s \leq s_1 \end{cases} \tag{12}$$

3 Equilibrium solutions and their commute patterns

In this section, the equilibrium solutions of CW are investigated considering the productivity effects, household activity conflicts as well as commute congestion as discussed hereinabove. Foremost, the solutions are classified according to the composition of firms in CBD as follows:

Case L: All firms adopt normal work schedule;

Case M: Some firms adopt CW schedule, while others have normal schedule;

Case R: All firms adopt CW schedule.

We look at the conditions when $s \geq s_1$. The commute patterns of both work schedule are independent of each other. Let $\zeta = 2\left(\frac{\beta}{s} + \frac{(\alpha+\beta)\epsilon_1}{2\alpha\cdot s}\right) > 0$. There is $\overline{T_i} = \frac{(\alpha+\beta)}{2\alpha\cdot s}\cdot N^i$. Therefore, according to Eqn. (7)-(12), $\zeta \cdot N^i$ is actually the combination of daily travel cost and activity cost of work schedule i resulting from commute, and it's linearly increasing with the number of employees adopting that schedule. Since $N^N \equiv N - N^C$ holds, with some manipulations, the individual net benefits of commuters defined in (5) become

$$\begin{aligned} \varDelta_N &= (\tfrac{nH}{N} - m\zeta)N^N + U + (m-n)H - \epsilon_2 mH \\ &= -\left(\tfrac{nH}{N} - m\zeta\right)N^C + U + (m-n)H - \epsilon_2 mH + (nH - m\zeta N), \end{aligned} \tag{13}$$

$$\varDelta_C = [\tfrac{nH}{N} - (m-n)\zeta]N^C + U + (m-n)H - \epsilon_2 mH - (\epsilon_1 - \epsilon_2)nH \quad N^C \in [0, N]. \tag{14}$$

At equilibrium, $\varDelta_N = \varDelta_C$ if both work schedules are adopted. Evidently, the individual net benefits $\varDelta_N$, $\varDelta_C$ are linear functions of N^C. Let $N_1 = \frac{2Hn}{(2m-n)\zeta}$, $N_2 = \frac{(1+\epsilon_1-\epsilon_2)Hn}{m\zeta}$, $N_3 = \frac{(1+\epsilon_1-\epsilon_2)Hn}{(m-n)\zeta}$, $N_4 = \frac{(2+\epsilon_1-\epsilon_2)Hn}{2m\zeta}$, $N_5 = \frac{(2-\epsilon_1+\epsilon_2)Hn}{2(m-n)\zeta}$, $N_6 = \frac{(\epsilon_1-\epsilon_2)H}{\zeta}$. Note that when $\epsilon_1 - \epsilon_2 = 0$, $N_2 = N_4$, $N_3 = N_5$. Figure 2 then depict the possible patterns of equilibrium solutions and Figure 3 show their domains with respect to $\epsilon_1 - \epsilon_2$ and N.

In Figure 2, the number of workers adopting CW schedule (normal schedule) is measured from the left (right) end of the horizontal axis. The solid and dashed lines represent the loci of individual net benefits of CW and normal schedule, respectively. The equilibrium points are denoted by $S(S')$. Note that Figure 2 only aims at sketching the trend of equilibrium points and the slope of lines may not reflect the actual case. It can be observed that the equilibrium solution

S of pattern V falls on the left-hand side, i.e., Case L, where all firms adopt normal work schedule. Equilibrium solutions of pattern II and IV fall on the right-hand side, i.e., Case R, where all firms adopt CW. As for pattern III, equilibrium solution falls in middle, i.e., Case M. The equilibrium number of CW workers N_{eq}^{C} can be calculated from $\Delta_N = \Delta_C$ as

$$N_{eq}^{C} = \frac{(1+\epsilon_1-\epsilon_2)Hn - mN\zeta}{2Hn-(2m-n)N\zeta}N = \frac{m}{(2m-n)}\frac{N-N_2}{N-N_1}N \qquad \text{(Case M)} \tag{15}$$

Finally, the equilibrium solution of pattern I depends on the location of the initial point. If the initial number of worker adopting CW is smaller than that at the intersection of Δ_N and Δ_C, the equilibrium falls in the left-hand side (Case L). On the other hand, if the initial number is larger than the intersection number, the equilibrium goes to the right-hand side (Case R). This is also the reason why there are two equilibrium points S and S' in Figure 2 pattern I. Generally speaking, firms follow normal schedule at the beginning, and that equilibrium in pattern I falls in the Case L follows readily too.

4 System Optimum

This section then follows the equilibrium analysis and evaluates the economic efficiency with different numbers of CW workers. The social surplus (or total net benefit) is calculated as the sum of individual net benefit, as

$$S(N^C) = \Delta_C \cdot N^C + \Delta_N \cdot N^N = \Delta_C \cdot N^C + \Delta_N \cdot (N - N^C),\ N^C \in [0, N] \tag{16}$$

According to Eqn.(13)(14), the first order derivative of $S(N^C)$,

$$\begin{aligned}\frac{\mathrm{d}S(N^C)}{\mathrm{d}N^C} &= \left[\frac{2Hn}{N} - (2m-n)\zeta\right] \cdot N^C + 2m\zeta N - (2+\epsilon_1-\epsilon_2)Hn \\ &= (2m-n)\zeta\frac{N_1-N}{N} \cdot N^C - 2m\zeta(N_4 - N), \qquad N^C \in [0, N]\end{aligned} \tag{17}$$

Visibly, $S(N^C)$ is a quadratic function of N^C when $N \neq N_1$ and maximizing social surplus is our purpose. The possible patterns of social optimal solution are sketched in Figure 4. Also the domain of optimum solutions with respect to $\epsilon_1 - \epsilon_2$ and N is depicted in Figure 5.

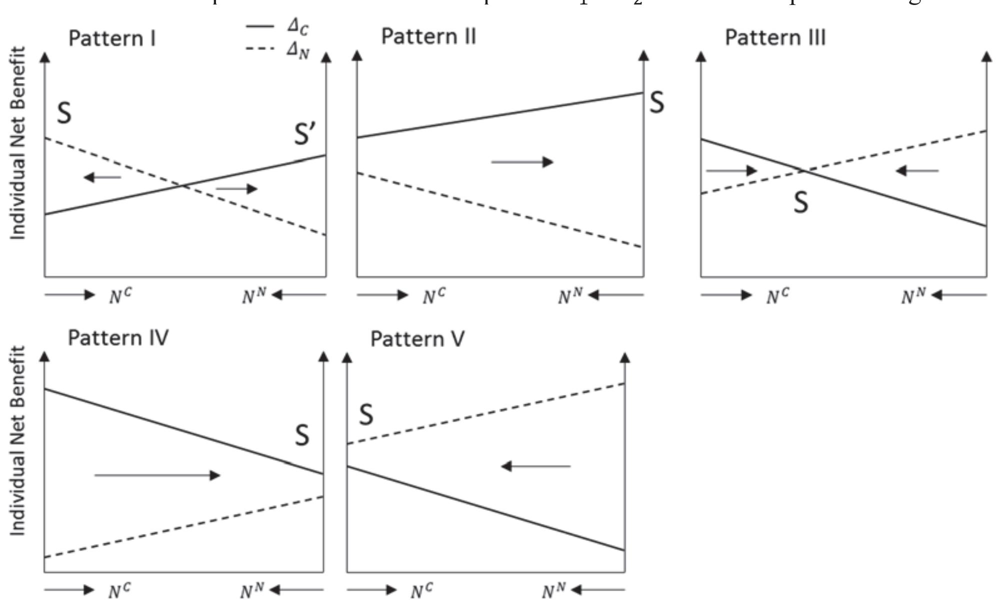

Figure 2 Possible patterns of equilibrium solutions.

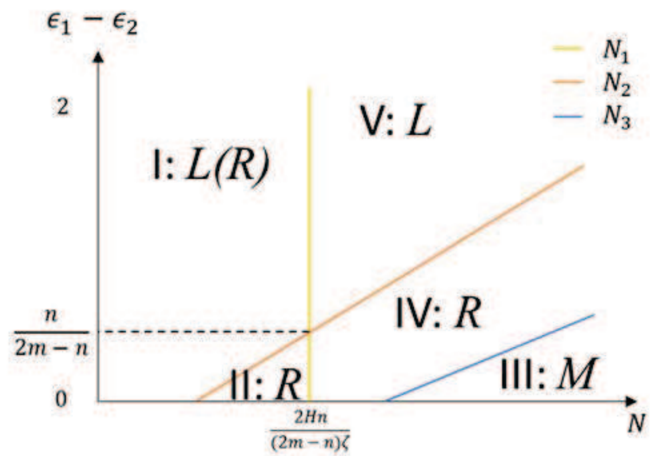

Figure 3 Domain of equilibrium solutions with respect to $\boldsymbol{\epsilon_1 - \epsilon_2}$ and $\boldsymbol{N}$.

When $N \leq N_1$ (Figure 4 ①-④), the parabola opens upwards, the optimum can only be corner solutions, either Case L or Case R. When $N \geq N_1$ (Figure 4 ⑤-⑦), the parabola opens downwards, it is also possible to have optimum located in between, i.e., Case M (pattern ⑥). More specifically, the optimal solutions in pattern ①,②,⑦ are located in Case R while optimums in pattern ③,④,⑤ are located in Case L. Note that the individual net benefit as well as the change in productivity, commute cost and activity utility in the corner solutions (Case L and Case R) remains the same as discussions in Section 3. As for pattern ⑥, calculated from $\frac{\mathrm{d}S(N^C)}{\mathrm{d}N^C} = 0$, the optimal number of CW workers N_{so}^C become

$$N_{so}^C = \frac{m}{(2m-n)} \frac{N - N_4}{N - N_1} \cdot N. \tag{18}$$

From Eqn.(7) (8), when N is relatively small, the gradient of productivity with respect to N^C or N^N is comparatively large. Thus, the optimal solutions stick to the corners where the total productivity becomes highest. If the unit time activity cost difference $\epsilon_1 - \epsilon_2$ is small, the saving in commute cost dominates the total net benefit increase. Thereby all commuters should adopt CW to minimize commute cost at optimum. With the increasing of $\epsilon_1 - \epsilon_2$, the activity cost increase in CW schedule turns its advantage into disadvantage. All commuters follow normal schedules at optimum. When N is getting larger, the rate of change in productivity with respect to N^C or N^N decrease and it is possible to reach optimum with some commuters adopting CW.

To further investigate the intrinsic relationship between the equilibrium and optimum solutions and to propose rational managing schemes, we compare and contrast the equilibrium and optimal solutions depicted in Figure 3 and Figure 5. As illustrated in Figure 6, the equilibrium solutions do not always coincide with those maximizing the total net benefit.

It can be observed only in zone I③, I④ and V⑤ (shaded in light purple in Figure 6) or in zone II① and IV⑦ (shaded in light blue), equilibrium solution coincides with optimum in the left-hand side (Case L) or right-hand side (Case R), respectively. In these situations, no other managing schemes are required. The market forces adjust themselves toward optimum. The light yellow shaded zone (zone I①, I②, V⑦) in Figure 6 represent the situation when equilibrium goes to the left (Case L), and optimum goes to the right (Case R). Namely, all firms should adopt CW instead of employing normal work schedule for the sake of social benefit. If so, the government should review the proportion of work days to days-off per pay period.

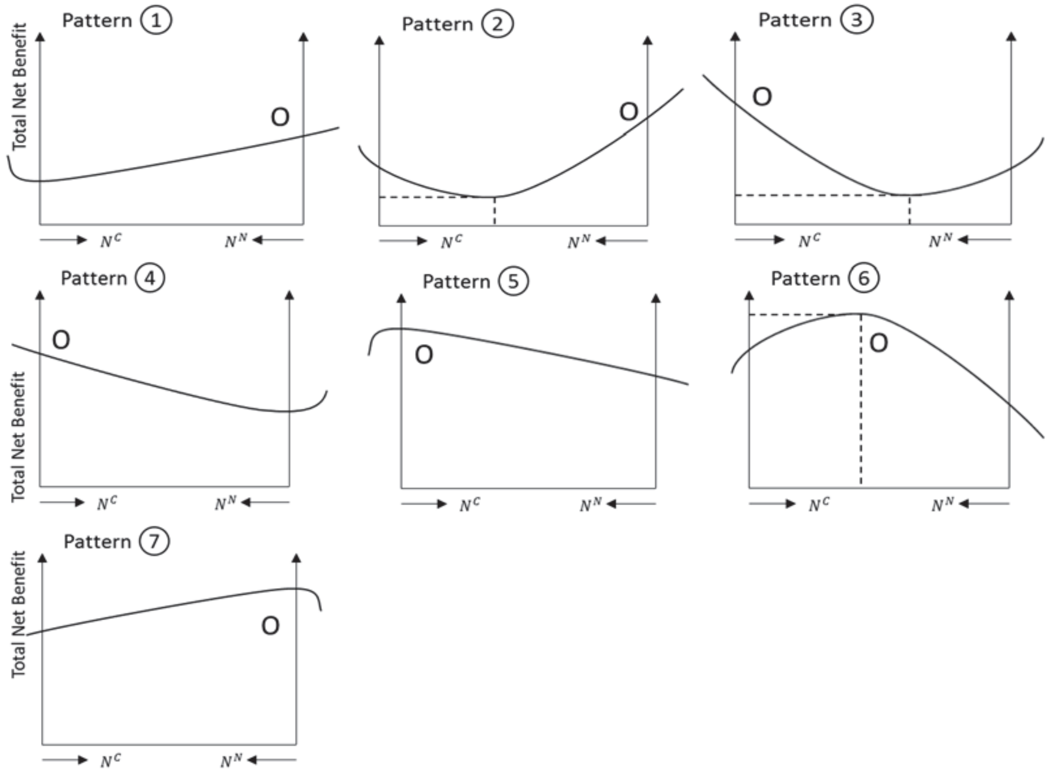

Figure 4 Possible patterns of optimal solutions.

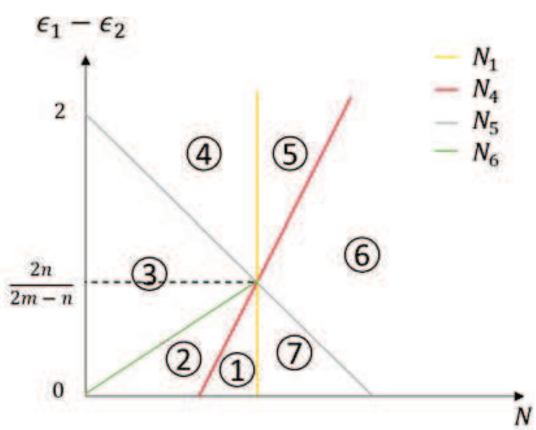

Figure 5 Domain of optimal solutions with respect to $\boldsymbol{\epsilon_1 - \epsilon_2}$ and $\boldsymbol{N}$.

The light red zone (zone V⑥) represents the situation when equilibrium goes to the left (Case L), and optimum locates in between (Case M). The light green zone (zone IV⑥) represent the situation when equilibrium goes to the right (Case R) and optimum locates in between (Case M). Lastly, the light green zone (zone III⑥) represent the situation when both equilibrium and optimum locates in between (Case M). As shown in Figure 6, for all points in this zone, there is $N > N_2 > N_4 > 0, \Rightarrow N_{so}^C > N_{eq}^C$, more employees should be encouraged to adopt CW to increase social welfare.

It is worth mentioning that from Figure 6, there is no such case when the equilibrium goes to the right (Case R), and optimum locates on the left (Case L). It is impossible to reach system optimum by shifting all commuters back to normal work schedule when all of them choose CW at equilibrium. Besides, there not exists the case when the equilibrium stays in between (Case M), and optimum goes to the corner (Case L, R).

5 Concluding Remarks

This study presented a preliminary but complete economic analysis of compressed work schedule(CW). CW is one of the flexible work arrangements which can significantly reduce commute trips per pay period and it is being promoted in some countries. Our work attempted to investigate the interrelation of CW and employees' travel behavior. CW's effects on individual output and work-family balance were also examined. Thus, a model describing employers' and employees' choices on their work schedule type is developed, with consideration of externalities resulted from productivity, travel cost, and activity utility. Without other policy intervention, i.e., when employers and employees choose their work schedule freely (either normal schedule or CW), the equilibrium number of employees adopting CW exists when there's no departure conflict between normal schedule and CW workers ($s \geq s_1$). Under mild assumptions, the individual net benefit is maximized at equilibrium with three possible solutions (Case L,M,R) depending on the total number of workers N and $\epsilon_1 - \epsilon_2$. Comparison between equilibrium and system optimum showed that the number of CW workers may not be equal between the two results. When there are some firms adopting CW at equilibrium (Case M), it's always beneficial to promote CW to reach N_{so}^C so as to maximize social welfare.

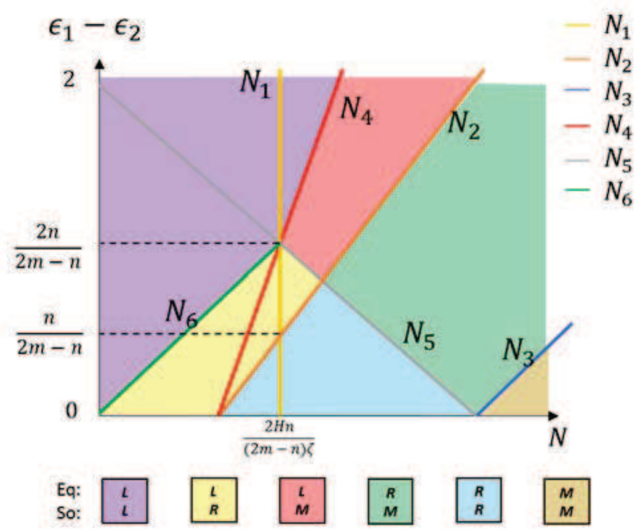

Figure 6 Comparison of equilibrium and optimal solution.

For one thing, strong agglomeration effect on productivity due to small N may lead to the conformity of equilibrium and optimum. For another, the constrained N or $\epsilon_1 - \epsilon_2$ restraints the total net benefit difference between equilibrium and optimum. The findings suggest that not only the commute cost, but also the individual output and work-family balance can affect workers' decision on their work schedule. Policy makers should review the total number of commuters and the unit activity cost difference between periods of on and off duty before the decision making of CW schedule promotion. Popularizing CW can reduce total commute cost but not necessarily increase social welfare. In some cases, the system can reach its optimum even without other policy intervention.

However, some assumptions have been made to simplify the analysis. Our model can be further developed by relaxing some of them in the future. Foremost, we primarily focused on the situation when normal schedule and CW workers share no common departure period in analyzing the equilibrium and optimum. Departure conflict between these two groups of workers can significantly increase traveler's commute cost and thereby lead to different equilibrium and optimum. Next, the CW schedules adopted by various firms may not be homogeneous. Casual observations suggest that workers adopting CW have extra days off at the end of a pay period, e.g., Friday or end of a month. Thus the same CW schedule is assumed. Yet employers and employees have the rights to design their own CW schedules freely. Last but not the least, as for the activity cost, two discrete types of activity cost ϵ_1, ϵ_2 are assumed to describe normal schedule workers' different values of work-family balance during on work and off work period. Fosgerau and Small (2017) considered the unit time activity cost as a function of the number of instantaneous off work workers. Nevertheless, the time-dependent activity cost can make it more complicated to determine the dominant component in the decision making of work schedule.

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