Intra-household work time synchronization

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Abstract

When considering benefits of marriage, economic theory usually stresses the possibility of joint consumption and the gains of division of labor supply. However individuals who are living together might simply derive utility from spending leisure time together. For these individuals it then pays off to synchronize work times with their partners.

This paper tests if partners coordinate with each other and synchronize their work times. We use a matching procedure where couples are first matched to other couples and then switch partners.

The empirical results suggest that (1) individuals who are married or are living together synchronize their work times although the effect is small, (2) more than 95 percent of the couples synchronize more than 80 percent of their possible work time hours and that (3) the main reason why couples are not able to synchronize their work times to a greater extend is because they have children.

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1 Introduction

The benefits of marriage that are usually stressed by economic theory are the possibility of joint consumption of household goods and the gains of division of labor. This economic view does allow for the interdependency of preferences between partners in the household but merely by studying the budget and time constraints.

It is, however, likely that individuals do not only derive utility from marriage because of material benefits alone. They might also derive utility from spending leisure time together. If this is the case, it can be hypothesized that it pays off for married or co-habiting individuals to synchronize their work hours, assuming that individuals within a household can coordinate their work schedules with each other. This paper examines if individuals within a household coordinate and synchronize their work hours with each other.

In traditional time allocation models individuals maximize their utility by choosing an optimal time allocation scheme given a budget and a time constraint.[1] These models focuss on choosing the optimal quantities of market work, household work and leisure time. If couples derive utility from spending leisure time together then it is important not only to consider the time quantities, but also the timing of certain activities. In other words, the amount of market work and timing of market work are interdependent. This makes the utility maximization problem more difficult and influences labor supply decisions.[2]

An example that gives some insight of how labor supply and work timing are interrelated is the demand for child care. There is empirical evidence that parents prefer to spend joint leisure time with there children (see Hallberg & Klevmarken (2003)). When parents synchronize their work times better, they are able to spend more joint leisure time with their children as a family. On the other hand, having young children influences the degree of work time synchro-

[1] See for example Becker (1965), Gronau (1986) and Chiappori (1988)

[2] Other papers that consider the timing of work are Hamermesh (1996, 2002), Sullivan (1996) and Van Velzen (2001).

nization negatively (See Hamermesh (2000), Hallberg (2003) and Van Velzen (2001)). Since paid child care is expensive, parents might choose to synchronize their work time less, such that the costs of child care are reduced. Making child care more available at a lower price not only increases the demand for paid child care, it also results in more possible joint leisure time of parents with their children and more work time synchronization. Furthermore it might lead to an increase of labor supply of females.

Although many papers examine what influences the amount of work hours that individuals work on the market, relatively a few papers consider the timing of market work hours. Hamermesh was among the first who paid attention to the extent to which couples[3] synchronize their work times. In Hamermesh (2000) he replaces each non-single male with a randomly selected non-single male and each non-single female with a randomly selected non-single female thereby generating random couples. Comparing the work time overlap[4] between the real couples and the generated random couples he finds that the real couples schedule their market work hours to allow joint leisure more than the generated random couples.

Jenkings & Osberg (2003) and Hallberg (2003) also test if spouses synchronize their work times. Jenkings & Osberg replace each non-single male with a single male with similar characteristics and each non-single female with a single female with similar characteristics.[5] Comparing the work time overlap of the matched singles with the real couples they find that real couples have about 5 percent more work time overlap. Hallberg (2003) matches a single male and a single female into a pseudo couple and then matches this pseudo couple to a real couple conditioned on certain personal characteristics following a matching algorithm of Rubin (1979) which uses mahalanobis distances. A matched single

[3]Note that when we use the word spouses we are referring to individuals who are married or who are living together.

[4]We define work time overlap as the number of hours that individuals of a couple spend on the market at the same time.

[5]They also match every husband with every wife (which results in 11.758971 matched pseudo couples) and found that the average work time synchronization of the real couples is about 5% larger than that of the pseudo couples

can be regarded as the nearest neighbour of the non-single given the singles sample. Comparing the work timing of the pseudo-couples with the real-couples, Hallberg (2003) finds evidence of coordination on synchronous work times and finds that market work and leisure timing are intra-household dependent.

It can be questioned however, if constraints imposed by society are indeed the same for singles and couples. If singles face different constraints imposed by society then it might be that the observed difference of work time overlap is due to differences in constraints. For example, living expenses are relatively higher for singles. Furthermore, singles do not have the possibility to gain from division of labor or have other benefits from living together.

Furthermore it can be argued that there is a selection problem. First, individuals who have more synchronized work times (and therefore more synchronized leisure time) have a higher probability of meeting each other. In this case, finding a significant higher work time overlap might be the consequence of a selection effect. It is also possible that singles synchronize work time with other singles. If they are in search for a partner they synchronize their time with other singles in the same social group. Non-singles already have a partner and therefore might not synchronize their work times to the same extent. Finding a significant lower work time overlap might then also be the consequence of a selection effect.

A third point that can be made is that singles with (young) children are a rather specific group. Their time allocation choices are likely to be different compared non-single individuals.

In general it is hard to identify if work time synchronization between the spouses is due to the difference in constraint imposed by society, due to a selection effect or is the consequence of synchronization due to coordination. To quote Hamermesh (2000, p.24);

> *"I cannot identify whether the ultimate cause of this demand for jointness arises, as I have modeled it, from the couple's preferences or, alternatively, from the technology of household production. In-*

deed, distinguishing these possibilities is a fruitful avenue for future research ...”

The main objective of this paper is to test if there is work time synchronization by using a matching strategy where couples are first matched to other couples and then switch partners. This matching procedure diminishes selection effects and excludes the possibility that the synchronization effect is caused by differences in constraint. This matching procedure is compared to a matching procedure where singles are matched to non-singles as in Jenkings & Osberg (2003) and Hallberg (2003) using Dutch data.

Furthermore, we examine which percentage of the number of work hours that could be synchronized is actually synchronized and what causes the variation in this percentage given certain personal characteristics.

The paper is organized as follows. Section 2 presents a theoretical model. Section 3 describes the data that is used. Section 4 matches non-singles to singles and examines if there is a work time synchronization effect. Section 5 proposes an alternative matching strategy where couples are matched to other couples and examines if there is a synchronization effect, which can be attributed to active coordination of couples. Section 6 shows how the variation in work time overlap is explained by relevant personal characteristics. Finally section 7 concludes.

2 Time Allocation Model

Consider a two-person household where individuals within the household allocate their time to market work or to leisure time.[6] A time period T is defined, which can be a day or a week, and it is assumed that this time period is divided in equal time units t. For simplicity T can be defined as one day, and one time unit can be defined as one hour.

If both individuals within the household allocate their t^{th} hour to leisure then

[6]This section is largely based on Hamermesh (2000)

this t^{th} hour is considered as joint leisure time. All other allocation choices of both individuals will not result in joint leisure time. The possible leisure timing allocation schemes for all units t is then represented as:

$$\begin{aligned} L^m &= L^m[l_1^m \cdot (1 - l_1^f), ..., l_T^m \cdot (1 - l_T^f)] \\ L^f &= L^f[l_1^f \cdot (1 - l_1^m), ..., l_T^f \cdot (1 - l_T^m)] \\ L^j &= L^f[l_1^m \cdot l_1^f, ..., l_T^m \cdot l_T^f] \end{aligned} \tag{1}$$

Where l_t^s indicates one if individual s consumes leisure at the t^{th} hour and zero otherwise, for $s = m(ales), f(emales)$. Note that L^s is leisure time that is spend alone. The maximization problem of the household can now be described as:

$$U = U(L^m, L^f, L^j, C) \tag{2}$$

subject to the following constraint:

$$C = \sum_{t=1}^{T} w_{mt} \cdot (1 - l_t^m) + \sum_{t=1}^{T} w_{ft} \cdot (1 - l_t^f) \tag{3}$$

Where C is consumption and w_{st} is the wage rate of individual s of hour t. Wage rates are assume to be exogenous and may vary over time. Household behavior is optimal if the household utility function is maximized subject to equation 3.

Individuals will choose to work on the market at hour t if the market wage is higher than the reservation wage for that particular hour. However, the reservation wage is not only determined by preferences to consume market goods but also by preferences to spend leisure time together. The first component has to do with the quantity of leisure time, while the second component has to do with the timing of market work. Furthermore, this model shows that the optimal amount of joint leisure time is influenced by the timing strategy of the individuals within the household, but also influenced by the constraints.

3 General Data Information

In November 2001 a Dutch survey was held named the 'The State of the Country'. This survey was the initiative of the Research Institute SCHOLAR of the University of Amsterdam (Schooling, Labor Market and Economic Development) and the Netherlands Press Association, a coordinating institute for regional newspapers. The total number of subscriptions is about 1.7 million, equally spread over the Netherlands. The questionnaire contains information on market work, household work, and child care for both partners simultaneously. Moreover, there is information about the financial situation, on health, education, training, career and social environment. Finally, there is a wide spectrum of attitude questions with respect to work, political and life events and measures of individual well being. The data has information on 14.572 Dutch adults of which 9.340 are men and 5.232 are women.

The following work timing question was posed to respondents and their partner if they had one:

"At what time do you normally start (end) working?"

Respondents could answer this question accurately to the minute. Using this work timing question it is possible to generate an 'overlap' variable for individuals who are married or co-habiting[7]:

$$O = \sum_{t=1}^{T} (job_t^m \cdot job_t^f) \tag{4}$$

$$\begin{cases} job_t^s = 1, & s \text{ works on the market on time } t; \\ 0, & \text{otherwise.} \end{cases} \tag{5}$$

Where O represents the work time overlap variable and job_t^s represents if respectively the male or female works on the market at time t. For reasons of simplicity we converted this variable into one that is measured in hours with a precision of 2 decimals.

[7]Throughout the remainders of this paper we will use the word spouses. If so, we refer to individuals who are married or living together.

4 When singles are matched to non-singles

4.1 Matching procedure and descriptive statistics

In this section we match single individuals to non-single individuals based on personal characteristics. We create a sample of simulated couples by replacing each non-single[8] male with a single male with similar characteristics and each non-single female with a single female with similar characteristics.

In order to do so Mahalanobis distances are used (See Rubin (1979)). The Mahalanobis distance is defined as the distance between two N dimensional points scaled by the statistical variation in each component of the point. Define the "mean point" in the multidimensional space as centroid. The Mahalanobis distance is then the distance of a case (one single observation) from the centroid in the multidimensional space, defined by the correlated independent variables (if the independent variables are uncorrelated, it is the same as the Euclidean distance).[9] A single individual that was matched to non-single individual can be regarded as the nearest neighbour of the non-single based on the singles sample.

Using this matching method there is information on 3074 couples, 554 single males and 629 single females in our sample.[10]

The matching variables that are used to define the Mahalanobis distances should be matching variables that influence the extent to which timing of work hours between two partners is possible. Some obvious matching variables are age, education level and the number of individuals living in the respondents community. Education level is defined on an eight point scale, where one is lowest education level and eight is highest education level. the number of individuals living in the respondents community is indicated as living area. Living area is defined on a five point scale (<5000; 5000-20000; 20000-50000; 50000-100000; >100000).

[8] Non-singles are defined as individuals who are married or who are living together.

[9] This procedure is explained in Appendix A

[10] Note that the number of real couples is greater than the aggregate number of single males and single females. We do not believe this is problematic since one single individual may be matched more than once to another single individual of the opposite sex, so the potential amount of different simulated couples is 554x629.

Various studies find that having young children or the birth of a new born baby influences work time synchronization negatively (See Hamermesh (2000), Hallberg (2003) and Van Velzen (2001)). Therefore we include the number of children between certain age levels (0-4; 4-12 and 12-18). Note that since we match singles to non-singles here, we should be aware of the fact that singles with children are a rather specific group which might influence the empirical findings.

Furthermore it is important to include the number of hours that individuals work on the labor market. Suppose that a non-single and single are matched and that both individuals work from nine to five. If their partner and simulated partner, work respectively, 8 hours and 14 hours on the labor market it is likely that we observe a higher work time overlap for the simulated couple. However this overlap is not due to synchronization but simply because there is a difference in absolute work hours between partners.

For the sake of simplicity we refer to the male of the simulated couple pseudo male and to the female of the simulated couple as pseudo female.

Table Table 1 shows the descriptive statistics of the matching variables of both real and simulated couples:

-Insert Table 1 about here-

Table Table 1 shows that the average age and education level of the simulated couples are higher compared to the real couples.

The simulated couples on average have less children. Testing if work time overlap of the real couples minus the overlap of the pseudo couples is significantly different from zero might be problematic since young children negatively influence work time time synchronization. As a consequence the amount of work time that is synchronized will be underestimated using this matching method.

The number of market work hours of the pseudo females is on average higher compared to the females of the real couples while the reverse holds for male individuals. The average hours of market work of the pseudo couple females is higher, which leads to an underestimation of the synchronization effect. males

work on average less hours on the market, which is a more severe problem, since overestimation of the synchronization effect might be the consequence.

4.2 Empirical results – When singles are matched to non-singles

A t-test can be used to examine if there is a significant difference in work time overlap between the real couples and the simulated couples. Table (2) shows the results of the t-test where we compare the mean overlap of real couples to the mean overlap of the simulated couples.

-Insert Table 2 about here-

The estimation results show that real couples do not have significantly more work time overlap compared to the simulated couples. It should be noticed that the difference in work time overlap is likely to be underestimated.

The empirical results of Jenkings & Osberg (2003) are in favor of work time synchronization. They find that that the work time synchronization of real couples is significantly five percent larger compared to the simulated couples.

Hallberg (2003) finds that by adjusting working schedules and the timing of leisure and household work, couples experience about 14 percent (50 minutes) in terms of more time when they can potentially meet during a normal work day. However, in their paper he defines the amount of simultaneous leisure time as the aggregate simultaneous time spent in leisure and household work. It might be the case that the synchronization effect Hallberg (2003) finds, is caused by the timing of household work and does not depend on the timing of market work[11]. Due to the data restrictions we cannot replicate Hallberg's result because we do not have information on the timing of household work. Our results might indicate that the synchronization effect found by Hallberg is due to synchronization of household tasks rather than the synchronization of

[11]In fact, individuals usually dislike certain types of household work and it is likely that couples perform household task, like doing the dishes and cooking, together. Singles, of course, have no partner to perform these household tasks with, hence it is likely that matched singles will do worse in synchronizing household work hours compared to couples.

work time. By using this matching method we do not find empirical evidence for work time synchronization.

As argued before, it is hard to identify what causes the non-significance mean difference in work time overlap between the simulated and real couples using this matching method. The non-significant difference in work time overlap might have me due to measurement errors.

First, when comparing the means of the real couples to those of the simulated couples (see table 1) they turn out to be significantly different. Second, it is not clear how constraints that singles and non-singles face are different. Third, there is a selection problem and it is not clear in which direction this selection problem influences work time overlap.

5 When non-singles are matched to other non-singles

5.1 Matching procedure and descriptive statistics

In this section we propose a different simulation method, which can be used to test if synchronization of work hours is due to coordination between the individuals within the household with respect to their work timing.

Consider a couple where the individuals of the couple are denoted by M_i and F_i. Conditioned on personal characteristics couple $\{M_i;F_i\}$ is matched to another couple $\{M_j;F_j\}$, which we will refer to as simulated real couple (SRC).[12]. Then both couples switch partners so that we have two new couples, $\{M_j;F_i\}$ and $\{M_j;F_i\}$, which we will refer to as pseudo couples ($PC1$ and $PC2$).

All four couples face the same constraints imposed by society but there is coordination between the individuals of the real couple and the simulated real couple while there is no coordination between the individuals of the pseudo couples. In order to test the work time synchronization hypotheses we can do the following:

[12]It must hold that $j \neq i$

1. Compare the timing of market work $\{M_i; F_i\}$ and $\{M_{js}; F_j\}$ and find no significant difference in the timing of market work.

2. Compare the timing of market work of respectively $\{M_i; F_i\}$ and $\{M_j; F_j\}$ with the possible pseudo couples, i.e. $\{M_i; F_j\}$ and $\{M_j; F_i\}$ and find a significant difference in the timing of market work.

Comparing the timing of market work between $\{M_i;F_i\}$ and $\{M_j;F_j\}$ will give more information about the quality of the simulation. Finding a significant difference in the timing of market work between respectively $\{M_i; F_i\}$ and $\{M_j; F_j\}$ with the possible pseudo couples is then empirical support for work time overlap between the individuals of a household due to coordination (A more elaborate explanation is given in Appendix (B)).

When households are matched to other households this happens on the basis of an identification number. First each household receives an identification number based on the characteristics of males and females. To give a simple example, suppose that we condition merely on the education level of males and females, which is measured on a 1 to 8 point scale. Suppose furthermore that there are three households with education levels $[E_m, E_f]$:

Household	E_{male}	E_{female}
A	8	7
B	6	5
C	6	5

Household A will now receive identification number 87 while household B and C receive identification number 65. Therefore, based on education level household B and C could be matched. Note that this method requires that there should be an exact match between the two households. The following personal characteristics are used as matching variables[13]:

[13]Some variables are divided into categories while this was not done when we matched singles to non-singles. The reason is that more possibilities make the probability of an exact match smaller although it is more precise. We had to make a trade of between the sample size that can be used eventually and the precision of the simulation.

1. Education level in three categories (low, middle and high).
2. Age in three categories (18-35; 35-50 and 50-65).
3. Having children who are living at homes (dummy)
4. The number of individuals living in the respondents community measured on a five point scale (<5000; 5000-20000; 20000-50000; 50000-100000; >100000).
5. Work hours in 22 categories, so that each couples should work approximately the same amount of hours on the market (We defined >21 hours as one category).

Exact matching of couples based on these personal characteristics gives 449 unique groups that contain information of 1770 couples. It is possible that some groups contain more than two couples since there is more than one exact match for a certain couple. In this case a couple is randomly drawn from that group with equal probability given the fact that the couple that is randomly drawn is not the real couple itself.

-Insert Table 3 about here-

The descriptive statistics of the real couples and the simulated real couples are shown in table (3). Table (3) show the same variables as table (1), such that it is possible to compare the descriptive statistics of both simulation methods.

The simulated real couples have very similar descriptive statistics compared to the real couples. The difference in means in table (3) between the simulated real couples and the real couples are not significant. Although a child-dummy variable was used to match couples, table (3) also shows that the number of children between certain age levels are very similar.

5.2 Empirical Results – When non-singles are matched to other non-singles

Before comparing the work time overlap between the real couples and the pseudo couples we should compare the work time overlap of the real couples with that of the simulated real couples. A t-test which compares the work time overlap of both real couples can be regarded as a simulation quality test. If the descriptive

statistics are very similar but the difference of work time overlap turns out to be significantly different from zero, then this indicates that the simulated real couples are not 'good quality' look alikes. Table (4) indicates that real couples and simulated couples have on average the same amount of work time overlap, which indicates that the simulated real couples are good quality look alikes.

-Insert Table 4-6 about here-

Table (5) and (6) shows the t-test results where the mean work time overlap of the real couples and simulated real couples is compared to that of the pseudo couples ($PC1$ and $PC2$). Both tables indicate that the pseudo couples have significantly less work time overlap compared to the real couples and simulated real couples. The difference in work time overlap is on average 0.10 hours which is about 6 minutes each day.[14]

The selection effect is a problem when singles are matched to non-singles. When non-singles are matched to other non-singles the selection effect should be less of a problem, since both real couples are married or living together and have the same amount of work time overlap. Furthermore, the constraints imposed by society are similar, since the individuals of the real couples and the simulated real couples have about the same personal characteristics, are all married or living together and have about the same working time overlap.

The significant higher work time overlap for the real couples and simulated real couples compared to the pseudo couples can be regarded as the result of work time synchronization due to coordination.

6 Explaining the variation in work time overlap

In order to examine which personal characteristics influences how 'good' couples are in synchronizing their work time overlap, it is important to realize that the number of work time hours influences the work time overlap that each couple can have. Therefore we define our dependent variable as follows:

[14] In order to see if this result is robust we repeatedly performed the simulation method and found that this result is stable.

$$y = \frac{\text{work time overlap}}{\min(\text{work hours male, work hours female})} \tag{6}$$

The dependent variable indicates the number of work hours that is synchronized relatively to the number of work hours that could be synchronized.

Table 7 shows the frequency table of the generated overlap variable.

-Insert Table 7 about here-

The data suggest that more than 95 percent of the couples synchronize more than 80 percent of their possible work time hours. Over 65 percent of the couples synchronize the maximum amount of work time. How the variation of y is influenced by certain personal characteristics is shown in Table (8).

-Insert Table 8 about here-

Table (8) shows the OLS estimation results when we regress the number of work hours that is synchronized relatively to the number of work hours that could be synchronized on certain personal characteristic variables. Table (8) is divided in two part, part (1) and part (2). The explanatory variables that are used in part (1) are age dummies (reference group are males/females who are 51-60 years old), education level, the number of children within the household separated in certain age intervals, living region, a dummy variable that indicates one if a couple makes use of paid child care and a dummy variable that indicates one when a couple have no children.

Having children between four and twelve results in significantly less work time overlap. Having children younger than four or older than twelve years old appears to have no significant influence on work time overlap. Parents with children younger than four years old usually choose either to make use of paid child care or to make sure that one of the parents stays at home. If one of the parents chooses to take care of the child full-time then we do not observe a work time overlap and these couples will drop out of our sample. The positive significant effect of paid child care is confirmed by our estimation results. Although the number of children between some age intervals is not significant,

the data suggest that having no children influences work time synchronization in a positive manner.

The education level of males is positively significant.[15] Higher educated individuals are more likely to have more control over the timing of their working hours compared to less educated individuals.

In the second part of table (8) we elaborate our empirical model adding the following explanatory variables: If males/females have irregular working hours, If males/females work for the government and the hourly wage rate of males and female.

Individuals are asked, even though they claim to work on fixed hours if they also work on irregular working hours. We hypothesize that if individuals are willing to work at irregular hours that this is because of two reasons. First, they might already work on irregular, but fixed, hours. Secondly, it might be that working on irregular hours pays more money and we would expect that if the hourly pay at the irregular working hours is more than the reservation wage at those hours individuals will prefer to work. The latter is likely to influence the extent to which couples synchronize their work times negatively. The empirical results suggest that the extend to which couples synchronize their work times is negatively influenced if females work claimed they worked on irregular hours and is not significantly influenced when males are working irregular hours although the sign tends to be negative.

Individuals who are working at a governmental institution are more likely to have nine-to-five jobs and furthermore have in general better secondary labor conditions (in terms of maternity leave, strictness of when to begin or to end working on a certain day). We would therefore expect that individuals who are working for a governmental institution are in a better position to synchronize their work times. Since we want to compare individuals who are working for the government with individuals who are working for firms we generated a set of control variables. These control dummies indicate one for individuals who are not working for the government nor working for firms. These are for example

[15]Note that the education level of males and females are highly correlated (about 0.4).

individuals who are farmers, students or starting entrepreneurs. The estimation results suggest that couples where females work for a governmental institution are doing a better job in synchronizing their work times. The coefficient for males, however, is insignificant and tends to have an negative sign.

The hourly wage rate of males has a positively significant effect on the extent to which couples are able to synchronize their work hours while for females the opposite is true. In the Netherlands it is on average the case that males are the main income providers and they work full time on the market. Having a higher wage rate might give additional information about the position of the male in his job. If the position of the males improves he earns more income and it can be hypothesized that he will substitute away from market work towards leisure. If he derives utility from spending additional joint leisure time with his partner (and child) then he can substitute away from market work towards joint leisure hours with his partner more easily. The income distribution of females is known to be double-peaked since woman often choose between a full time and a part time job. One reason is that females usually the ones who spend more time caring for the children. If the wage rate is higher for females then this might induces woman to work less hours on the market, not necessarily to increase the joint leisure time with their partner but maybe more to increase the joint leisure time with the children and to reduce the cost of paid child care. The latter might indicate that cause females substitute away from working hours maybe not towards leisure time but towards household time. Surely, this reasoning depends on the price of paid child care relative to the hourly wage rate. It should however be noted that examining the influence of wage rates on the extent to which couples synchronize there work times is beyond the scope of this paper.

7 Conclusion

If couples derive utility from spending leisure time together, it is expected that these couples will synchronize their market work time in order to increase their

utility levels.

Hamermesh (2000), Jenkins and Osberg and Hallberg (2003) find empirical evidence that couples synchronize leisure by adjusting their working schedules, timing of household work and leisure. They adopt a simulation method where singles are matched to non-singles and assume that the constraints imposed by society are similar for singles and non-singles.

It might be argued that singles face different constraints compared to non-singles. As economic theory suggest, there are economies of scale to marriage or to living together. Furthermore, if singles are matched to non-singles then the significant higher work time overlap might be the consequence of a selection effect. Hence, it is not possible to identify if a significant higher work time overlap is due to the difference in constraint imposed by society, due to a selection effect or is the consequence of synchronization due to coordination.

It is possible to match couples to other couples for which hold that their personal characteristics are similar and for which hold that the difference of work time overlap is not significantly different from zero. When couples are matched to other couples they switch partners. Then we compare the work time overlap of the two couples before the partner switch with the work time overlap of the two couples after the partner switch. In this case the selection effect diminishes since both real couples are married or living together and have the same amount of work hours overlap. Furthermore, the constraints imposed by society are similar, since the individuals of the real couples and the simulated real couples have about the same personal characteristics, are all married or living together and have about the same working time overlap.

In this paper there is empirical support for market work synchronization in the Netherlands. Although the effect is small, we find that pseudo couples have significantly less work time overlap compared to real couples of about 6 minutes per working day. This result can be regarded as the result of work time synchronization due to coordination.

Over 95 percent of the couples synchronize more than 80 percent of their possible work time hours. It might be that a possible explanation for the small

synchronization effect that is found is that it might be difficult for most individuals to have full control over their market work timing. If this is the case, individuals are more likely to synchronize their leisure time by timing housework activities (which can be the finding of Hallberg (2003)) or by planning carefully when they perform certain leisure activities.

It seems that the the main reasons why couples are not able to synchronize their work times to a greater extend is because they have children. The estimation results also suggest that wage rates, working for the government and working at irregular work hours influence the extent to which couples are able to synchronize their work times, which might also be child related.

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Appendix A

This appendix shows how singles are matched to non-singles with nearest available pair matching using the Mahalanobis distance (for a more elaborate explanation see Rubin (1979)). For simplicity we show how single males are matched to non-single males using the similar notation as in Rubin (1979).

Let the sample G_{1m} of non-single males have sample size N_{1m}. Let the sample G_{2m} of single males have sample size N_{2m}. Nearest available pair matching first orders the G_{1m} units and then matches each unit of G_{1m} to the closest unit of G_{2m}.

x_{im} is the $N_{im} \times p$ data matrix of X based on the random sample G_{im} for $i = 1, 2$. $\bar{x}_{im}$ is the $1 \times p$ sample mean vector in G_{im}. The pooled within sample covariance matrix of X based on the random samples is then:

$$S_m = \frac{[({x_{1m}}^T x_{1m} - N_{1m} \cdot {\bar{x}_{1m}}^T \bar{x}_{1m}) + ({x_{2m}}^T x_{2m} - N_{2m} \cdot {\bar{x}_{2m}}^T \bar{x}_{2m})]}{(N_{1m} + N_{2m} - 2)} \tag{7}$$

The Mahalanobis difference between a unit from the sample G_{1m} with score X_{1m} and a unit from sample G_{1m} with score X_{2m} is then defined as:

$$(X_{1m} - X_{2m}) S_m^{-1} (X_{1m} - X_{2m})^T \tag{8}$$

The algorithm matches a single male from the sample G_{2m} to a non-single male from the sample G_{1m} for which holds that the Mahalanobis distance has the smallest value compared to all other possible matches. The same matching procedure is used to match single females to non-single females.

Appendix B

This appendix shows that it is necessary to simulate one couple that is very similar to the real couple from the total sample of real couples. Simulating one couple rather similar to the real couple enables us to generate two pseudo couple outcomes and two real couple outcomes for each household.

Consider a couple in our sample where the individuals of the couple are denoted by M_i and F_i. Conditional on personal characteristics M_i is matched to another male drawn from the sample M_{-i}. F_i is matched to another female drawn from the sample F_{-i}. The simulated male and female are denoted by M_{js} and F_{ks} and together they are considered to be a pseudo couple.[16] The simulated situation can be graphically illustrated as follows:

$$\begin{array}{ccc} M_i & \Leftrightarrow & F_i \\ M_{js} & & F_{ks} \\ \Updownarrow & & \Updownarrow \\ F_j & & M_k \end{array}$$

The arrows indicate that there is interaction (communication or coordination) between two individuals. If we would like to test that synchronization of leisure time results from coordination between two individuals, at least to some extend, then comparing the possible joint leisure time between $(M_i; F_i)$ and $(M_{js}; F_{ks})$ is not sufficient. This is shown by the following steps[17]:

1. There is coordination between M_i and F_i
2. There is no coordination between M_{js} and F_{ks}
3. M_{js} interacts with F_j and F_{ks} interacts with M_{ks}.
4. Assume for simplicity that M_k=M_i.
5. Case 1: F_j has different personal characteristics than F_i
   Case 2: F_j has similar personal characteristics thanF_i

[16]Note that it holds for the subscript that $i \neq j \neq k$. Furthermore, s stands for simulated.
[17]Note that we use = to indicate that two individuals have same personal characteristics.

6. Suppose case 1 holds and a positive significant difference is observed in the timing of work between $(M_i; F_i)$ and $(M_{js}; F_{ks})$. This positive significant difference can be caused by:
   (a) Coordination between M_i and F_i
   (b) Coordination between M_{js} and F_j
   (c) Difference personal characteristics of F_j and F_i. Due to this difference the two couples ($(M_{js}; F_j)$ and $(M_i; F_i)$) are facing different constraint imposed by society.
7. Suppose case 2 holds and a positive significant difference is observed in the timing of work between $(M_i; F_i)$ and $(M_{js}; F_{ks})$. This positive significant difference can be caused by:
   (a) Coordination between M_i and F_i
   (b) Coordination between M_{js} and F_j
8. Empirical support for work time synchronization is then found if:
   (a) Comparing timing of market work $(M_i; F_i)$ and $(M_{js}; F_j)$ and finding no significant difference in the timing of market work.
   (b) Comparing timing of market work of respectively $(M_i; F_i)$ and $(M_{js}; F_j)$ with the possible pseudo couples, i.e. $(M_i; F_j)$ and $(M_{js}; F_i)$. Finding that real couples time their market work better compared to the pseudo couples, in the sense that there is significantly more overlap.

Table 1: **Descriptive Statistics when matching singles to non-singles**

	Real couples			**Simulated couples**		
	N	**Mean**	**Std.Dev.**	**N**	**Mean**	**Std.Dev.**
Age of male	3074	44.254	9.311	3074	44.712	9.016
Education level male	3074	5.800	1.929	3074	5.832	1.905
# children between 0-4	3074	0.161	0.772	3074	0.062	0.241
# children between 4-12	3074	0.375	1.226	3074	0.143	0.462
# children between 12-18	3074	0.433	2.216	3074	0.190	0.532
work hours male	3074	9.117	1.923	3074	9.042	1.793
living area male	3074	2.226	0.965	3074	2.192	0.920
Age of female	3074	42.964	9.338	3074	43.730	9.136
Education level female	3074	5.399	1.978	3074	5.510	1.933
# children between 0-4	3074	0.161	0.772	3074	0.313	0.247
# children between 4-12	3074	0.375	1.226	3074	0.267	0.628
# children between 12-18	3074	0.433	2.216	3074	0.232	0.945
work hours female	3074	7.764	2.564	3074	7.879	2.375
living area female	3074	2.226	0.965	3074	2.156	0.960

Table 2: **t-test overlap difference – Matching singles to non-singles**

	Real couples	**Simulated couples**	**Difference**
Mean	6.901	6.946	-0.045
St.Error of mean	0.043	0.037	0.035
St.Dev. of mean	2.376	2.099	1.870
Number of observations	3074	3074	3074

Note: * significant at 10% level, ** significant at 5 % level,*** significant at 1 % level.

Table 3: **Descriptive Statistics of one-to-one matched couples**

	Real couples			**SR**		
	N	**Mean**	**Std.Dev.**	**N**	**Mean**	**Std.Dev.**
Age of male	1758	43.412	9.607	1758	43.462	9.601
Education level male	1758	6.047	1.810	1758	6.065	1.805
# children between 0-4	1758	0.157	0.798	1758	0.144	0.750
# children between 4-12	1758	0.378	1.310	1758	0.374	1.250
# children between 12-18	1758	0.376	1.925	1758	0.351	1.795
work hours male	1758	8.929	0.646	1758	8.923	0.647
living area male	1758	2.078	0.814	1758	2.078	0.814
Age of female	1758	42.258	9.629	1758	42.230	9.592
Education level female	1758	5.660	1.885	1758	5.642	1.880
# children between 0-4	1758	0.157	0.798	1758	0.144	0.750
# children between 4-12	1758	0.378	1.310	1758	0.374	1.250
# children between 12-18	1758	0.376	1.925	1758	0.351	1.795
work hours female	1758	7.855	1.757	1758	7.850	1.756
living area female	1758	2.078	0.814	1758	2.078	0.814

Table 4: **t-test overlap overlap difference – Matching real couples with simulated real couples**

	Real couples	**Real Simulated couples**	**Difference**
Mean	7.369	7.394	-0.025
St.Error of mean	0.047	0.046	0.036
St.Dev. of mean	2.000	1.923	1.500
Number of observations	1770	1770	1770

Note: * significant at 10% level, ** significant at 5 % level,*** significant at 1 % level.

Table 5: **t-test overlap overlap difference – Matching Real Couples with generated pseudo couples $P1$ and $P2$**

	Compare overlap variable with PC 1			**Compare overlap variable with PC 2**		
	Real Couples	**PC 1**	**Difference**	**Real couples**	**PC 2**	**Difference**
Mean	7.369	7.267	0.103	7.369	7.304	0.065
St.Error of mean	0.047	0.046	0.018***	0.047	0.045	0.031**
St.Dev. of mean	2.000	1.954	0.786	2.000	1.901	1.318
Number of observations	1770	1770	1770	1770	1770	1770

Note: * significant at 10% level, ** significant at 5 % level,*** significant at 1 % level.

Table 6: **t-test overlap overlap difference – Matching Simulated Real Couples with generated pseudo couples $P1$ and $P2$**

	Compare overlap variable with PC 1			**Compare overlap variable with PC 2**		
	Simulated Real Couples	**PC1**	**Difference**	**Real couples**	**PC 2**	**Difference**
Mean	7.394	7.267	0.128	7.394	7.304	0.090
St.Error of mean	0.046	0.046	0.031***	0.046	0.045	0.018**
St.Dev. of mean	1.923	1.955	1.302	1.923	1.901	0.777
Number of observations	1770	1770	1770	1770	1770	1770

Note: * significant at 10% level, ** significant at 5 % level,*** significant at 1 % level.

Table 7: **Frequency table of y ($\frac{\textbf{work time overlap}}{\min(\textbf{work hours male, work hours female})}$)**

y	**Frequency**	**Freq in %**	**cum. freq. in %**
≤ 0.6	41	2.322	2.322
0.60 - 0.65	1	0.057	2.378
0.65 - 0.70	7	0.396	2.775
0.70 - 0.75	7	0.396	3.171
0.75 - 0.80	18	1.019	4.190
0.80 - 0.85	47	2.661	6.852
0.85 - 0.90	124	7.022	13.873
0.90 - 0.95	288	16.308	30.181
0.95 - 1	81	4.587	34.768
1	1152	65.232	100
Total	1766	100	

Table 8: **What causes variation in synchronized work time relatively to the number of work hours that could be synchronized.**

Variable:	**(1)**		**(2)**	
age male 21-35	-0.022		-0.021	
	-0.780		-0.720	
age male 36-50	-0.007		-0.006	
	-0.410		-0.310	
age female 21-35	0.034		0.050	†
	1.180		1.690	
age female 36-50	0.002		0.016	
	0.110		0.850	
$log(education_{male})$	0.018	†	0.006	
	1.900		0.600	
$log(education_{female})$	0.006		0.005	
	0.680		0.490	
Makes use of paid child care	0.040	**	0.028	*
	3.200		2.170	
No Child Dummy	0.025	*	0.019	†
	2.460		1.820	
log(# child 0-4)	-0.003		0.000	
	-0.570		-0.010	
log(# child 4-12)	-0.010	**	-0.012	**
	-3.160		-3.400	
log(# child 12+)	0.002		-0.001	
	0.780		-0.290	
Living area	0.007		0.005	
	1.540		1.150	
w_{male}	.		0.001	*
	.		2.550	
w_{female}	.		-0.001	†
	.		-1.720	
Male works irregular hours	.		-0.012	
	.		-1.240	
Female works irregular hours	.		-0.076	**
	.		-7.740	
Male works for government	.		-0.014	
	.		-1.560	

The t-values are printed below the coefficients
Significance levels : † *: 10%* ∗ *: 5%* ∗∗ *: 1%*

... table 8 continued

Variable:	**(1)**	**(2)**	
Female works for government	.	0.024	**
	.	2.740	
Control variable$_{male}$	.	0.011	
	.	0.880	
Control variable$_{female}$	.	0.008	
	.	0.620	
Intercept	0.873	0.891	
	37.720	34.280	
N	1758	1515	
R-squared	0.0277	0.0888	

The t-values are printed below the coefficients

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%