

Intra-Household Bargaining, Resource Allocation and Cost of Gender-Based Violence in Egypt: The Role of Asset Ownership and Gender Role Attitudes

Eleftherios Giovanis and Oznur Ozdamar

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Abstract

Wives' violent abuse is a common and widely acknowledged issue. However, the subject has received little empirical research in the developing world. This study explores the intra-household inequalities in Egypt, considering the gender role attitudes, female asset ownership and the domestic violence wives experience from their husbands. We apply a standard intra-household collective model and estimate the spouses' labor supply equations. The empirical analysis relies on the Egypt Economic Cost of Gender-Based Violence Survey (ECGBVS) conducted in 2015. The findings showed that if the wife's wage increases by 1 Egyptian pound, then she transfers 0.28 to 0.34 to her partner, while husbands, under the same increase, transfer 0.15 to 0.19 pounds to their wives. Moreover, an increase of one Egyptian pound in the household non-labor income increases by 0.62-0.72 the wife's non-labor income. Also, the wife's share in non-labor income rises by 0.62-0.72 Egyptian pounds for every pound increase in the household's non-labor income. Focusing on the distribution factors, we find that the difference between the couples' age, conservative gender role attitudes and violence reduce women's bargaining power. The reduction in the annual wage ranges between 230 and 400 pounds per year with increases in age differences and gender role attitudes. It might reach 2,500 pounds per year if women have undergone any form of domestic violence from their partner, including physical, psychological, or sexual abuse. On the other hand, female asset ownership empowers women and enhances their bargaining power.

Keywords: Domestic Violence, Cost of Violence, Egypt; Employment Loss, Gender Role Attitudes, Intra-Household Allocation, Women Empowerment

JEL Classifications: D13, D63, J12, J16, J22, R2

ملخص

الإساءة العنيفة للزوجات هي قضية شائعة ومعترف بها على نطاق واسع. ومع ذلك، لم يتلق هذا الموضوع سوى القليل من الأبحاث التجريبية في العالم النامي. تستكشف هذه الدراسة أوجه عدم المساواة داخل الأسرة المعيشية في مصر، بالنظر إلى مواقف الدور النوعي وملكية المرأة للأصول والعنف المنزلي الذي تعاني منه الزوجات من أزواجهن. نحن نطبق نموذجًا جماعيًا معياريًا داخل الأسرة ونقدر معادلات توريد العمل للأزواج. يعتمد التحليل التجريبي على مسح التكلفة الاقتصادية للعنف القائم على النوع الاجتماعي في مصر. الذي أجري في عام 2015. وأظهرت النتائج أنه إذا زاد أجر الزوجة بمقدار 1 جنيه مصري، فإنها تنقل 0,28 0,34 إلى شريكها، بينما يقوم الأزواج، في ظل نفس الزيادة، بتحويل 0,15 إلى 0,19 جنيه لزوجاتهم. علاوة على ذلك، فإن زيادة جنيهاً مصرياً واحداً في دخل الأسرة غير العامل تزيد بمقدار 0.62-0.72 دخل الزوجة غير العامل. كما أن حصة الزوجة في الدخل غير العمالي ترتفع بمقدار 0.62-0.72 جنيه مصري عن كل زيادة في دخل الأسرة من غير العمالة. بالتركيز على عوامل التوزيع، نجد أن الفرق بين عمر الأزواج ومواقف الدور المحافظ بين الجنسين والعنف يقلل من قدرة المرأة على المساومة. ويتراوح الانخفاض في الأجر السنوي بين 230 و 400 جنيه سنوياً مع زيادة في الفروق العمرية ومواقف دور الجنسين. قد يصل إلى 2500 جنيه سنوياً إذا تعرضت النساء لأي شكل من أشكال العنف المنزلي من شريكهن، بما في ذلك الاعتداء الجسدي أو النفسي. أو الجنسي. ومن ناحية أخرى، فإن ملكية المرأة للأصول تمكن المرأة وتعزز قدرتها التفاوضية.

1. Introduction

One of the most prevalent gender-based violence (GBV) types is intimate partner violence (IPV). It is one of today's most critical social issues (Garcia-Moreno et al., 2006; Vyas and Watts, 2009), and it occurs in all societies, regardless of economic status and the country's development stage, and among people of all races and ethnicities. In particular, if regional customs, local traditions, cultural norms, and the legal system uphold men's superiority over women, then women everywhere carry a disproportionate share of the world's burdens and are more susceptible to abuse and various forms of demeaning violence (Krug et al., 2022; Schuler et al., 2006; World Health Organization & Pan American Health Organization, 2012; Mshweshwe, 2020).

It primarily affects women and girls, having numerous short-run and long-run physical, psychological, sexual, and emotional effects. GBV negatively impacts women's well-being and quality of life and prevents them from participating in the labour market and socio-cultural events and contributing to society. Violence harms not only women but also their families, the community, and the country as a whole, associated with significant expenditures, including increased health care and legal fees, as well as productivity losses, which influence the overall development (Violence, W. I. G. B., 1999; Cruz and Klinger, 2011; Duvvury et al., 2022).

According to studies, IPV is a substantial obstacle to development since it negatively impacts employment outcomes, particularly for women, thereby reducing their opportunities to participate in the labour market, earn an income, and make their own choices regarding their families and children's health and education (Gibson-Davis et al., 2005; Vyas and Watts, 2009) independently. IPV also has a wide range of harmful effects on women's reproductive, mental, and physical health, as well as an elevated risk of HIV/AIDS (Campbell, 2002; Dunkle et al., 2006; Dillon et al., 2013).

This study intends to shed some insights into the relationship between domestic abuse, violence and women's empowerment, which is important because investing in the female labour force should be a priority of policymakers and societies overall. To fuel the economy's further expansion in the future, human capital, mainly in the form of women's investments in their children's health, education and quality of life, is essential (Schultz, 2002). Women's economic participation is beneficial because it encourages growth, increases diversity, reduces income inequality, and strengthens the financial system (Gonzales et al., 2015; Kochhar et al., 2017; IMF, 2018).

The study aims to employ an intra-household collective model to investigate the impact of violence on spouses' labour supply and sharing rule. Numerous studies have implemented intra-household collective models to examine the labour supply, allocation of expenditures and consumption, sharing rule and the bargaining power between spouses (Chiappori, 1988, 1992, 1997; Lundberg et al., 1997; Chiappori et al., 2002; Attanasio and Lechene, 2002; Arias et al., 2004; Blundell et al., 2005, 2007; Browning et al., 1994, 2009; Hendy and Sofer, 2010; Menon and Perali, 2012; Chavas et al., 2018). We adhere to the framework used by Rapoport et al. (2011), Giovanis and Ozdamar (2019), and Molina et al. (2022).

Intra-household bargaining refers to negotiations between household members to reach household-related decisions, such as whether to work, save and spend more on health, education, or children's related expenditures. In other words, household members are the agents who negotiate how to distribute the benefits of cooperation, which in this case, are the benefits of cohabitation. Inherent

to the collective model is the so-called sharing rule, which determines the within-household distribution of household income. This rule is sometimes considered a measure of the bargaining power of individual family members, and the fact that it is expressed in monetary terms is an attractive aspect of the resource-sharing rule. The sharing rule is also helpful in recovering information on the economic well-being of household members, such as the proportion of income or amount of money each household member shares with the other members. Thus, in this study, estimating the sharing rule between women exposed to domestic violence and those who are not, we can measure the female bargaining power and identify the intra-household inequalities and the influence of the IPV on female empowerment expressed by participation in the labor market.

While there are numerous studies exploring IPV and domestic violence in Egypt (Hassan et al., 2004; Vizcarra et al., 2004; Diop-Sidibé et al., 2006; Yount and Li, 2010; Rico et al., 2011; Yount et al., 2014; Hawcroft et al., 2019) to the best of our knowledge, no study has yet been conducted on intra-household inequality in Egypt, examining the impact and costs of gender domestic violence on labour supply. Moreover, we examine three distinct forms of domestic violence: physical, psychological, and sexual. Another contribution of the study is that we consider the ownership of assets and property and gender role attitudes as distribution factors, along with those used commonly in the literature, such as differences in partners' ages.

We will estimate the joint labour supply equations of wives and husbands using the Generalized Methods of Moments (GMM) method. The empirical work relies on the Egypt Economic Cost of Gender-Based Violence Survey (ECGBVS) 2015. The findings support the collective household model, as the sharing rule and bargaining power of spouses depends not only on their characteristics but also on their partners' characteristics, such as wage, education, and age. In general, domestic violence negatively affects the bargaining power of wives who hold conservative gender role attitudes that legitimize their husbands' violent behavior in particular situations. The harmful effects of violence stemming from physical contact are the most severe, followed by those stemming from sexual and psychological abuse. On the contrary, female asset ownership enhances wives' bargaining power.

The remaining sections of the paper are organized as follows: In section 2, we present the literature evaluation on domestic violence and its costs, and in section 3, we briefly discuss the main theories of domestic violence. In section 4, we describe the methodology and data, and in section 5, we report the empirical findings. The sixth section addresses the study's findings and policy implications, and section 7 presents the concluding remarks.

2. Literature Review

Domestic violence against women has substantial social and economic repercussions and is associated with significant health expenditures and loss of productivity. According to the last report by the WHO (2021), IPV is an essential source of stress, depression, and suicidality among women. It also causes reproductive and sexual health problems and injuries. According to estimates, between 38 and 40 per cent of female homicides are committed by intimate partners. IPV against women affects children's health outcomes, such as low birth weight and development issues (WHO, 2021). The Center for Disease Control in the United States estimates the yearly

expenditures associated with IPV hospitalization, medical care, and lost productivity at \$5.8 (Aizer, 2010).

Prior research has primarily concentrated on intimate partner violence (IPV) in North America and Europe, followed by studies conducted in Asia. Still, relatively few studies examine domestic violence in the countries of the Middle East and North Africa (MENA) region (Alhabib et al., 2010). Previous research indicates that women's participation in economic activities can sustainably contribute to human capital growth. Using the Demography and Health Survey (DHS) across 36 South Asian, Latin American, Caribbean and Sub-Saharan African nations, Smith (2003) found a significant correlation between female decision-making power and children's nutrition. Using data from the 1995 DHS for Egypt and multivariate analysis, Kishor (2000) demonstrated strong relationships between women's empowerment and child health.

Sanin (2022) conducted an intriguing study using the Difference-in-Differences (DiD) method and found that following the installation of a coffee mill in Rwanda, women in the catchment areas are 18 per cent more likely to work for cash. They are also 26 per cent less likely to have reported any domestic abuse or violence from their partner over the past 12 months. In addition, hospitals in the catchment regions are 20 per cent less likely to record admissions of a patient who is a victim of domestic violence during a harvest month compared to one month before the commencement of the harvest season. In contrast, the study by Au Yong Lyn (2021) implies the opposite. More specifically, the author investigated the effect of the gold mining boom on women's bargaining power in Mexico, using as an exogenous event the financial crisis of 2007-2008. The findings indicate that residents of gold-endowed localities have greater bargaining and decision-making power but are more likely to face domestic abuse from their partners.

There are numerous studies exploring the IPV and domestic violence in Egypt. Women who had been physically or emotionally abused as children were more likely to be victims of domestic violence as adults, according to a study by Yount and Li (2010) that used data from a nationwide sample of 5,272 married Egyptian women. When women's living standards increase, the likelihood of sexual domestic violence falls. The study found higher rates of domestic violence among wives with either unusually lower or higher levels of education than their husbands. In 2013, Abdelhai and Mosleh (2015) conducted a cross-sectional study using a systematic random sample of 376 pregnant women visiting the antenatal care outpatient clinic at the largest university hospital in Egypt. According to the study's findings, 30.6% of women experienced domestic violence, and 25.2% were physically abused by their husbands. Vizcarra et al. (2004) randomly selected 3,974 women between the ages of 15 and 49 with at least one child younger than 18 in communities in Chile, Egypt, India, and the Philippines. The authors employed a self-report questionnaire (SRQ) to evaluate emotional well-being. An SRQ score of 8 or above or a history of suicide attempts indicates a poor mental health status. IPV that involved physical contact occurred when a man threatened, hit, or beat his partner within the previous year. Examples of psychological abuse included cases where women were intimidated or left alone. Participating women reported an SRQ score of eight or above, ranging between 22.5% in Egypt and 41% in Chile. In all countries except Chile, IPV significantly positively correlated with high SRQ scores. Current physical IPV was associated with suicide attempts among women in the Philippines, Egypt, and India, while suicide attempts among Egyptian and Indian women were linked to psychological violence. In Chile, 12% of women, 2.6% of Egyptian women, 7.5% of Indian women, and 1.6% of Filipino women reported having attempted suicide.

Abu-Elenin et al. (2022) explored the domestic violence of women in Egypt during the COVID-19 pandemic. The research was carried out using a cross-sectional survey of 2,068 married women. The most common types of violence against women that have increased significantly since the COVID-19 pandemic are as follows: twisting arms/pulling hair (32.8% pre-COVID-19; 75% post-COVID-19); leaving the house without informing or giving the wife money (12.2% pre-COVID-19; 30.3% post-COVID-19); limiting her interaction with her family members (26.1% pre-COVID-19; 40.4% post-COVID-19). The study reveals that low women's education, husband's low educational and job rank, low household income, and tobacco use of husbands and women who were married at a young age were significantly associated with higher domestic violence rates.

In 2018, Mahfouz et al. (2021) conducted a comparative cross-sectional study among a sample of Egyptian rural households in Minia, Upper Egypt. A total of 380 married women (aged 19 to 35) participated in the study. One-fourth of the participants reported violence exposure. Just under 70% of the women in the research reported having food insecurity, with 15.3% having very low food security, 37.4% having moderate food insecurity, and 17.1% having severe food insecurity. The empirical results show that food insecurity, women's education, and husband's occupation were predictors of IPV. Women from food-insecure households were four times more likely to experience IPV. Also, illiterate women are more likely to report IPV than those who have completed educational attainment of a secondary school or higher; yet, IPV is less likely to be reported by women whose husbands hold professional or semiprofessional jobs.

Yount et al. (2014) conducted a study examining 564 ever-married women between the ages of 22 and 65 in rural Minya, Egypt, using data from the 2005 Egypt Demographic and Health Survey (EDHS). In addition, in 2012, they interviewed 30 married women, ages 22 to 52, about their jobs and experiences with IPV; 16 of these women had experienced physical IPV, whereas the other 14 had not. Their findings show that women who experienced any kind of IPV in the month preceding the survey, but particularly those who experienced psychological IPV, spent slightly more time working than women who had not experienced any form of IPV. Yet, those exposed to any lifetime IPV and distal physical or sexual IPV spent less time in the labour market than their counterparts. The authors also show that daily domestic work is correlated with lifetime exposure to any kind of IPV.

This paper contributes to the literature by investigating the costs of Gender-Based Violence (GBV) and inequalities in Egypt using an intra-household collective model and estimating the sharing rules for three types of domestic violence; psychological, physical and sexual. Another contribution is we explore gender role attitudes and the importance of female asset ownership.

3. Theories of Domestic Violence

Previous studies have developed various economic theories and have applied models to incorporate theories from psychology and sociology related to domestic violence. The literature distinguishes between two motives, the *expressive* and the *instrumental* (Tauchen et al., 1991; Farmer and Tiefenthaler, 1997). The expressive violence theory refers to the effect of income and directly affects the husband's utility. In this situation, expressive violence does not necessarily involve physical abuse, but the husband may be able to vent economic tension through non-physical means (Tauchen et al., 1991). Specifically, increasing women's income may alleviate husbands' financial

strain and lessen domestic violence (Kruk et al., 2004; Angelucci, 2008; Arenas-Arroyo et al., 2021; Bhalotra et al., 2021). However, expressive violence can have positive and negative non-pecuniary returns. Haushofer et al. (2019) point out that since violence and the husband's wealth are substitutes in the expressive component of his utility, they are also substitutes in his overall utility. Consequently, rises in the husband's salary reduce instances of aggression against the wife. Therefore, in this case, the husband may find violence displeasing because he cares for the wife's and the family's well-being. On the contrary, husbands may derive direct pleasure from engaging in violence to assert dominance. In such cases, violence is "expressively pleasurable".

The second theory is the outside option. Previous studies have incorporated household bargaining and found that employment opportunities boosting wives' income enhance their outside options and their bargaining power and thereby reduce domestic violence (Tauchen et al., 1991; Farmer and Tiefenthaler, 1997; Aizer, 2010; Anderberg et al., 2016; Hidrobo et al., 2016; Haushofer et al., 2019). Similar to the outside option is exposure reduction. This is a theory developed by criminologists who contend that a rise in female work may lessen domestic violence due to a decline in the amount of time couples spend together, hence reducing the amount of time a woman is exposed to her husband (Dugan et al., 1999; Chin, 2011).

There are, however, theories that imply a positive association between women's resources and domestic violence, and these imply *instrumental* behavior. The first theory is the Male Backlash developed by sociologists who argue that an increase in women's income may lead to a rise in domestic violence because female employment may undermine the husband's conventional gender role as the "breadwinner", resulting in domestic violence (Macmillan and Gartner, 1999; Angelucci, 2008; Alesina et al., 2020; Au Yong Lyn, 2021). The second theory is instrumental violence or resource extraction, in which the husband exploits his spouse to extract resources for material gain by using physical force or the threat of violence. In this instance, he is attempting to improve his bargaining power; consequently, according to the theory of instrumental violence, a rise in women's resources may also cause more instances of domestic violence from their spouses (Bloch and Rao, 2002; Bobonis et al., 2013; Bhalotra et al., 2021). Although both theories suggest a positive association between women's resources and domestic violence, the Male Backlash hypothesis does not necessarily propose that the husband's motivation for exposing violence is to extract resources from his partner. Following the discussion in the previous section and the theories briefly presented so far, we will test the following hypotheses.

H₁: According to the theories of outside option and exposure reduction, an increase in the wife's participation in the labour market and salary will increase her bargaining power and, thus, reduce the incidence of domestic violence.

H₂: Depending on the husband's behavior, an increase in this income may lead to a decline in domestic violence if he finds it displeasing or will increase the incidence of domestic violence if he finds it highly pleasurable.

As we discussed earlier, exposure reduction refers to the time the couples spend together. Thus, as women participate more time out of home in the labour market, there are less likely to be exposed to domestic violence. Similarly, according to the outside option, women can increase their salary and bargaining power, reducing the likelihood of domestic violence. On the husband's side, the

findings will depend on his expressive behavior and how domestic violence affects his utility. The hypotheses H₃ and H₄ are:

H₃: If the instrumental theories of Male Backlash and resource extraction hold in a household, then the increase in the wife's salary will increase the incidence of domestic violence.

H₄: Education and other characteristics that affect the outside option and exposure reduction will affect woman's bargaining power and consequently the incidence of domestic violence. On the contrary, if theories of Male Backlash and resource extraction hold, then an increase in woman's education and salary may increase the incidence of domestic violence.

Hypothesis H₄ is related to the previous hypotheses. In our sample, more educated partners are involved in higher-wage jobs. Thus, more educated women may have more bargaining power and are less likely to experience domestic violence. Other characteristics include household size, where women may spend more time on household chores and caring for children and elderly family members. This implies that they also spend less time in the labour market or earn less, reducing their bargaining power and increasing the incidence of domestic violence. However, the results will depend on whether the husbands follow an instrumental behavior, where according to the Male Backlash theory, men abuse their partners because women earn more, and they undermine the role of their husbands as the “breadwinner” of the family. Also, according to the theory of resource extraction, husbands may exploit their spouses to extract resources for material gain by threatening their partner or using physical force.

Based on the intra-household collective model we present in the next section, households characterized by egalitarian gender role attitudes, husbands who find displeasing domestic violence and in cases where outside option and exposure reduction theories hold, we expect to find lower domestic violence costs and lower intra-household inequalities. However, we expect to find significant inter-household inequalities between wives who have experienced domestic violence and their counterparts who have not.

4. Methodology and Data

4.1 Methodology

The assumption of the model we estimate relies on the assumption that household decisions are Pareto-efficient (Apps and Rees, 1988; Chiappori, 1988, 1992; Browning et al., 1994; Bourguignon et al., 2009). Following Chiappori et al. (2002) and other studies (Rapoport et al., 2011; Giovanis and Ozdamar, 2019; Molina et al., 2022), we use a semi-logarithmic specification for the female and male labor supply equations:

$$h^f = f_0 + f_1 \ln w_f + f_2 \ln w_m + f_3 y + f_4 \ln w_f \ln w_m + f' s + \gamma' \mathbf{z} \quad (1)$$

$$h^m = m_0 + m_1 \ln w_f + m_2 \ln w_m + m_3 y + m_4 \ln w_f \ln w_m + m' s + \delta' \mathbf{z} \quad (2)$$

In the structural system (1)-(2), the h denotes the working hours per year for males and females represented by m and f respectively, w , y and s denote the wage, non-labour income and the distributional factors, respectively, while \mathbf{z} is a vector of individual and household characteristics, such as spouses' education level and urban-rural region. From (1)-(2), we can compute the partial derivatives with respect to spouses' wages, non-labour income and the distribution factors and then find the sharing rule. Since we employ many distribution factors, the estimated coefficients of s in equations (1)-(2) are defined, respectively, by f' and m' .

As we have highlighted, we will consider various distribution factors. The first is the common factor employed in previous studies and is the difference in age between men and women (Aronsson et al., 2001). The second distribution factor is the ownership of an asset, real estate or property, such as land, apartment, livestock, jewellery, car or truck, shop, factory, aquafarming, building, or valuable movables. The third distribution factor is gender role attitudes. This factor is an index constructed using ten variables and applying the principal component analysis. The questions refer to "whether the husband has the right to beat his wife" under various circumstances, such as if she neglects household chores, if she burns the food, if she neglects children, if she is sceptical, if she replies back, or if she is wasteful and others.

The fourth distribution factor involves domestic violence, and we will consider three types: psychological, physical, and sexual. Because some respondents have not experienced all kinds of violence, we will perform three regressions for each type to avoid multicollinearity issues. Therefore, using the gender role attitudes, ownership and domestic violence, we will compare the female labour supply and the sharing rule between those who have experienced abuse and violence with the women's labour supply who did not have that experience. For instance, women who have been victims of violence may have abandoned or lost their job, reduced working hours, or increased absenteeism because of domestic violence and any potential injury associated with it. Violence and injuries may ultimately affect the sharing rule and, thus, the intra-household resource allocation and inequalities. Since this model is well-documented in previous studies (Chiappori, 1992; Chiappori et al., 2002; Rapoport et al., 2011; Giovanis and Ozdamar, 2019; Molina et al., 2022), we provide more details about the maximization problem and the derivation of sharing rules in the Appendices.

We will estimate the simultaneous equations (1)-(2) by using the Generalized Method of Moments (GMM) with instruments for wages and income employed in previous studies (Chiappori, 1992; Rapoport et al., 2011; Giovanis and Ozdamar, 2019), as well as with additional instruments proposed in this study. More specifically, we use the Qism Markaz, which is the geographical level beneath the governorates we described earlier, the type of marriage (e.g. customary, legal or civil), the age-squared, things that make the wife happy, whether the respondent agreed with the marriage, and whether she lives with the parents-in-law or any of the husband's relatives. Household wealth indicators are other instruments employed, including questions on whether the household owns a radio, television, gas and electric stove, refrigerator, computer, air conditioner, motorcycle, private car, land, stock and bank account, and a commercial or industrial establishment. Other instruments include the confidentiality and the cooperation of the interview, such as whether the degree of cooperation was weak, medium, good or very good.

Reverse causality is a significant methodological concern when examining the influence of domestic violence on female economic empowerment, which justifies the use of instrumental

variables. The empirical research indicates that domestic violence against women is associated with higher female unemployment rates (Lloyd, 1997; Lindhorst et al., 2007). Domestic abuse may influence women's labour market involvement and income contribution (Anderberg and Rainer, 2013). Nonetheless, domestic abuse may prompt women to seek formal employment outside the house, for example, to escape domestic violence. It is also possible that women engage in labour market activities to strengthen their economic independence and eventually leave an abusive relationship. Nevertheless, employment might also impact domestic violence. For example, Bhalotra et al. (2021) discovered that a 1% rise in male unemployment is connected with a 2.75 % increase in the prevalence of physical aggression against women. In contrast, a 1 per cent decrease in female unemployment is related to a 2.87 per cent rise in the likelihood of victimization.

In this study, we seek to address the endogeneity issue arising from reverse causation between labour supply in two methods. In addition, non-labour income and wages are endogenous because unobserved individual traits that explain labour supply can be associated with non-labour income and wages. First, we can address this issue through the timing of the dependent variable, labour supply and domestic violence, as the domestic violence question in the survey precedes the labour supply and the time spent in the labour market. In this case, it is reasonable to assume that domestic violence affects female labour supply rather than previous employment status drives domestic violence. Furthermore, the survey was designed to identify the influences of domestic violence not only on employment status and labour supply but also on the contribution to household chores for both partners and the costs, services and support provided or received after the incidence of violence.

Second, we use a set of instrumental variables for non-labour income and wages, as mentioned earlier. Following the literature (Chiappori et al., 2002; Rapoport et al., 2011; Giovanis and Ozdamar, 2019), we instrument those regressors with the squared term, which acts as a proxy for professional experience in explaining wages and asset and wealth accumulation and, therefore non-labour income. We also use governorates as instruments attempting to capture unobserved characteristics, such as labour market, weather conditions, as well as gender role attitudes and social context, which are found to be very important in explaining Egyptian women's income (Assaad et al., 2015).

Whether the wife lives with the parents-in-law may affect the non-labour and labour income, as they may also contribute to the household. However, living with the parents-in-law may affect the female labour supply because they can contribute to the household, allowing the wife to spend more time in the labour market. On the contrary, if they are characterised by conservative gender role attitudes and less egalitarian norms, the wife may spend less time in the labour market. This also applies to whether the wife has agreed with the marriage and the type of marriage. Nevertheless, we assume that those variables may influence the wage and income and affect whether the wife or her partner should spend more time in the labour market. Furthermore, the inclusion of the other instruments does not reject the non-endogeneity hypothesis.

Another instrument used is a categorical variable about things that make the wife happy, such as children's success and happiness, comfort and family happiness, fun activities and hobbies, not having problems with husband, income increase and better living standards, religiosity, improving the country's conditions and stability. These dummy variables can be used as instruments for labour and non-labour income and also for gender role attitudes. In particular, we assume that respondents

that improved living standards and children's success and happiness may affect their wages in terms of productivity, as happier people can be more productive or make them put more effort into earning more and, thus, work more hours. We use the wealth indicators as instrumental variables for non-labour income since a higher wealth may affect non-labour income, which will influence the respondents' decision to spend more time at work or are looking to work in jobs that offer higher wages but require fewer hours of work. For instance, the household ownership of land and business or the house prices may influence the labour supply through the wage or the non-labour income they earn (Farmer and Tiefenthaler, 1996; Khan and Klasen, 2018).

The last instrument is the cooperation of the interview, which is based on the study by Powdthavee (2010). More specifically, he used the share of respondents who showed their payslips to the interviewer to predict household income, assuming that in this way, income is more accurately measured where the proportion of household members who showed payslips. Even though we do not employ the same instrument, we attempt to measure the accuracy of reported wages and non-labour income by the degree of cooperation during the interview.

Gender role attitudes and female ownership are other interesting indicators of bargaining power, apart from the fact that they may act as confounders to domestic violence and labour supply. For instance, more egalitarian households with progressive views about gender equality are likely to be positively related or positively affect female participation in the labour market and the time spent at work.

The intra-household model described in Appendix A and equations (1)-(2) requires that both partners participate in the labour market and earn a wage. Thus, we extend the analysis by also accounting for female labour market non-participation. Furthermore, economists have long been concerned about selection bias in observed wages. The selection equation for labour market participation is:

$$p_f = a_0 + a_1age_f + a_2age_m + a_3y + b'education_f + \gamma'education_m + a'z + u_f \quad (3)$$

Variable y is the household income, and subscripts f and m denote, respectively, females and males. We consider only married respondents and restrict the sample to couples participating in the labour market and earning wages. We also consider females that do not participate. We also insert quadratic terms on age, allowing for a flexible function form. Since education level is a categorical variable, we will estimate the set of coefficients by b' and γ' for women's and men's education.

Vector z includes other individual and household characteristics, and in particular, the ownership of real estate or property and whether the area is rural or urban. Other variables include the ratio of females in the household, whether the wife lives together with her parents and relatives or with the parents-in-law and husband's relatives, and whether she participates in any social activity. We assume that earnings do not vary based on the spouse's characteristics, and the female wage equation using the standard approach of human capital is as follows:

$$\ln w_f = b_0 + b_1age_f + b_2age_f^2 + b'education_f + \gamma'z + e_f \quad (4)$$

Where w is defined as the wage in equations (1)-(2), while age and education are key components of human capital and two of the most significant determinants of wage. We will implement the two-step Heckman selection model (Heckman, 1979) to correct sample selection and predict wages. Vector \mathbf{z} also contains the instruments excluded from the participation equation that refers to the geographical level beneath governorates, the Qism Markaz. Therefore, following previous studies, we include female and male characteristics in labour force participation, such as age and education level, as they may influence women's decision to participate in the labour market. On the other hand, we include only female and household characteristics in the wage equation (Nicodemo and Waldmann, 2009; Giovanis and Ozdamar, 2019).

Thus, in the first stage, we estimate the participation equation (3) using the Probit method, and then we obtain the estimated parameters to calculate the inverse Mills ratio (IMR). Then, in the second step, we include this ratio as a dependent variable in the wage equation (4), estimated using ordinary least squares (OLS). If the IMR is insignificant, then we accept the null hypothesis that the errors are uncorrelated, implying that there is no selection bias.

4.2 Data

The empirical analysis relies on the 2015 Egypt Economic Cost of Gender-Based Violence Survey (ECGBVS), which is accessible for academic purposes through the ERF NADA portal (OAMDI, 2022)². The sample was designed to provide representative governorate-level estimates using a 95% level of confidence. Design elements included a two-stage cluster sample. The initial sampling selected 1,000 enumeration areas (EAs) using a master sampling frame prepared by the Central Agency for Public Mobilization and Statistics (CAPMAS) in January 2010, which was based on the 2006 population census and then revised in 2013. In the second phase, 22 households were methodically selected from each EA in the rural and urban areas, and data from 21,448 households were collected. Women aged 18-64 who had resided in the household for at least a month prior to the survey were eligible for the interviews, and only one woman per family was selected for the interview (see UNFPA, 2016 and OAMDI, 2022 for further details on the sampling design).

In Table 1, we present the summary statistics for the incidence of domestic violence and the characteristics at the individual and household levels, such as age, education level, wages and labour supply, household size and area. We will estimate the regressions using three types of domestic violence. The first is psychological and emotional, which includes insults or making her sad, constantly doubting her, limiting her communication with friends, insisting on knowing her whereabouts, refuse to give her money for household needs. The second type is physical violence, such as burning, beating, slapping, and hitting. The third type is sexual violence, which includes forced sexual intercourse, degrading or demeaning sexual acts, and other forms of sexual coercion.

In panel A, we report the spouses' characteristics, which include wages, age, education level and labour supply. We should highlight that wage rates and labour supply are expressed annually. Wage rates are measured on Egyptian pounds and labour supply on working days per year. We also report the *t-statistics hypothesis* tests of equality between the couples of the variables. We reject the null hypothesis of equality in means between female and male wages, labour supply and age.

² For more details on the questionnaire and data access, please see <http://www.erfdataportal.com/index.php/catalog/238>

Moreover, the *t-statistic* in these cases is positive, indicating that males are, on average older, working more days and earning a higher salary. On the contrary, we accept the null hypothesis in the education level between husbands and wives, except for secondary school and above intermediate. In this case, we find a negative *t-statistic* implying that women are more likely to complete these levels of educational attainment. In panel B, we report the proportions of women experiencing domestic violence from their husbands. A higher percentage has experienced psychological violence at 41.80 per cent, followed by physical at 31.13, and 11.76 per cent of the sample has experienced sexual violence. In Panel C, we report the household size, which is 4.4 on average and the area, where almost 44.80 per cent lives in urban areas.

In Table 2, we report the correlation matrix. We show that psychological violence is more related to physical violence than sexual violence is connected to either one of them. Furthermore, we find that gender role attitudes are positively correlated to the incidence of all types of violence. As described in the methodology section, we construct gender role attitudes as an index using a set of questions about whether the husband has the right to beat his wife under various circumstances. Higher values imply more conservative roles and are more likely the respondent (wife) will justify her husband beating her. Therefore, we may conclude that wives characterised by traditional gender role values are more likely to allow their husbands to beat them and, thus, more likely to experience any type of domestic violence.

We find that male and female wages, labour supply, education attainment and age are related negatively to all types of violence, except for salaries and sexual violence, which seems there is no significant correlation. Moreover, female asset ownership is negatively related to violence, except for psychological violence, which is insignificant and may require more investigation. We also show a negative relationship between gender roles and wages, labour supply and education, implying that wealthier and more educated couples are less likely to report conservative gender role attitudes and, thus, less likely to experience domestic violence. As was expected, education is positively related to wages and labour supply. Nevertheless, it is interesting that female and male education is not associated with female labour supply.

Furthermore, we find a negative relationship between female asset ownership, wages and education level. These findings may seem surprising, as more educated people can be wealthier, as we have shown earlier. We should highlight that this variable takes a value of 1 if the wife owns an asset or property and 0 otherwise. However, the survey records the detailed responses of those who answered that they possess an asset by type, such as land, apartment, car or truck, livestock or poultry. Thus, the statistics show a negative relationship between those who own land, livestock and poultry and education, but we find a positive relationship between ownership of an apartment and education. This finding can be explained by the fact that women who own land or livestock are likelier to be farmers. Thus, they have completed lower education attainment and earn lower wages, while more educated people earning a higher wage are less likely to be farmers and own land and are more likely to purchase an apartment. Furthermore, wives who own the land and livestock could have inherited them from their families. Nevertheless, the negative association between female asset ownership, wages and education level are that most of the wives in the sample that own land, almost 51 per cent, 33 per cent own an apartment, and only between 0.5-7.5 per cent own a car, truck, building, shop, or factory.

5. Empirical Results

5.1 Heckman selection model

The first section of the results refers to the two-step Heckman selection model for female labour market participation, estimating equations (3)-(4). We estimated a two-step Heckman selection model (Heckman, 1979) to investigate the factors influencing women's labour force participation and wages. In the first column, we report the decision of labour market participation, which both spouses' characteristics can influence. In the second column, we present the estimates of the second stage, the wage regression, which is related to individual female characteristics. We find that wife's and husband's age show a non-monotonic relationship with the labour market participation, depicted by an inverted U-shaped curve. Specifically, this suggests that increases in age are associated with a greater likelihood of participation in the labour market, with a turning point for men aged 41 and 50 years old for women. The correlation between the education level of both couples and the probability of labour market participation is positive. Thus, highly educated women have acquired more skills and have better employment opportunities.

Nevertheless, regarding the husband's education level, the results show that wives are more likely to participate whose husband has completed postgraduate studies. We find an insignificant estimated coefficient of the non-labour income and the urban area, while the household size is negatively related to participation. We see a positive linear relationship between female age and wages in the wage equation. Although we were expecting an inverted U-shaped curve, as in the case of the participation equation, the estimated coefficient of the quadratic term in age becomes insignificant. University undergraduates and postgraduates report higher wages compared to the reference category, the primary school, and the other educational attainment levels. The area of the respondent's residence is insignificantly related to wages, as we found in the participation equation.

We conclude that the estimated coefficients are jointly significant based on the *Wald chi-square* statistic and its corresponding *p-value*. Thus, the overall performance of the regression overall is satisfying. The last coefficient we present is the Inverse Mills Ratio (IMR), which is estimated using the Probit estimation in the first stage, the participation equation. We observe the IMR is insignificant, and hence, we accept the null hypothesis that the errors are uncorrelated, implying that there is no selection bias.

5.2 Determinants of Domestic Violence

In Table 4, we report the estimates for the determinants of domestic violence using the Logit model. We remind the dependent variable takes the value of 1 if the respondent has experienced domestic physical, psychological, or sexual violence and 0 if they have not experienced any domestic violence. We also note that using the Probit model does not change our concluding remarks. The first determinant is the wage gap which is defined as the difference between the logarithms of male and female wages.

The results show that as the gender wage gap increases, the likelihood of women experiencing domestic physical or psychological violence increases. On the other hand, we found no statistically significant relationship between the gender wage gap and the incidence of sexual violence. Our findings are consistent with previous studies that found that a narrowing in the gender wage gap leads to reduced assaults and homicides of women (Aizer, 2010; Perova et al., 2021). However,

most studies have explored physical violence, while we further explore psychological and sexual violence. Moreover, as mentioned earlier, the impact of the wage gap on sexual violence is insignificant. Alternatively, we may use the ratio of female wages over the total wages (wages of both males and females). The concluding remarks remain the same in this case as well.

Regarding sexual violence, our findings are not consistent with previous studies that found a negative impact relationship between the gender wage gap, income inequality and sexual violence (Rashada and Sharaf, 2016; Abramsky et al., 2019). However, Abramsky et al. (2019), using a cluster randomised trial, found that income affects physical violence both at the baseline and longitudinally but affects sexual violence at baseline only. Furthermore, previous studies investigate sexual harassment and abuse in the workplace instead of sexual IPV (Antecol and Cobb-Clark, 2004; Cortina and Berdahl, 2008; Folke and Rickne, 2022). On the other hand, the study by Kayaoglu shows that when women who are the only income earners in the household are more likely to experience physical and sexual IPV compared to women who have similar incomes (Kayaoglu, 2022). Another explanation is that 12.03 per cent of the sample has experienced a sexual IPV incident, as shown in Table 1, which is significantly lower compared to 42.79 per cent of physical IPV and 31.13 per cent of psychological IPV. Thus, this may imply that the wage gap is insignificant and that other factors determine sexual violence.

Regarding the difference in spouses' ages, we find a negative and significant coefficient in the regressions of physical and sexual violence, but it becomes insignificant in psychological violence. We should also highlight that we performed the regressions using the female and male ages. In this case, we find insignificant coefficients for the females, while male age is negatively related to physical and sexual violence. Thus, older males are less likely to abuse their partner. The results are consistent with previous studies that argue that relationship power, which is the degree to which one can act independently of a partner's control, influence a partner's actions increases when the difference in partner's ages is lower (Pulerwitz et al., 2000; Begley et al., 2003; Ryan et al., 2008; Seth et al., 2010). The study by Hindin et al. (2008) shows that women whose husbands are at least five years older are less likely to experience an incidence of IPV than women who are closer in age to their partners or who are older in Zambia. On the other hand, they found an insignificant relationship between the age difference and IPV. Similarly, in the study by Castro et al. (2008) controlling for spouses' education and other individual and household characteristics, age differences were not consistently associated with experiencing IPV (Castro et al., 2008).

Therefore, while the expectation is that IPV should reduce where the spousal age difference is narrower, we found the opposite results. More specifically, the age gap may pose several problems, including differences in maturity and opinions. For instance, a couple's sexual life may be affected later on, early planning for children may be required, and the couple may face issues with ageing and early widowhood (Kim et al., 2015). Furthermore, IPV may rise when women in such a relationship decline or negotiate sex, explaining why the age difference is positively related to decreased longevity, particularly for women (Adebowale, 2018). However, our findings show a negative relationship between age difference and physical and sexual violence. One explanation is older men are expected to be more self-aware, self-sufficient and mature than their wives and hence better able to overlook and tolerate some inadequacies of their wives in terms of character and behavioural attitudes (Adebowale, 2018). Also, another explanation is that the age difference in most of the married couples in our sample ranges between 2-10 years, implying that there are no very large gaps. Another important factor is not the age difference per se but the age at marriage.

For instance, the study by Coll et al. (2023) found the risk of physical IPV was 3.3 times higher among women married at age 15 compared to young women married at age 24 in 48 low and middle-income countries. In our sample, the average age at marriage is 20.5, and almost 67 per cent was married at 19 years old and over.

In most cases, we find a negative relationship between domestic violence and the education attainment level of both partners. Especially domestic violence is less likely in households with women who completed a university or higher degree, while men who have completed secondary school and above are less likely to abuse their partner. This may confirm the theory of expressive violence since high-educated people earn more, and thus, increases in partners' salaries reduce the likelihood of domestic violence. Furthermore, high-educated women in ours ample earn a higher salary and participate more days in the labour market, which explains the outside option theory discussed earlier.

Female asset ownership is negatively related to domestic violence, and this is explained by the expressive violence theory or by noncooperative bargaining models, which predict that an increase in women's economic empowerment through earned income and financial gains from asset ownership decreases the level of domestic violence (Lundberg and Pollak, 1994; Farmer and Tiefenthaler, 1996; Khan and Klasen, 2018). Conservative gender role attitudes, as expected, are positively related to domestic violence. As we discussed earlier, women characterised by traditional gender role values are more likely to allow their husbands to beat or insult them and justify their actions, and thus, more likely to experience domestic violence.

Household size leads to a higher likelihood of domestic violence. This finding can be explained by the outside option and exposure reduction theories described in the previous section. More specifically, household size may imply a reduction in the labour market, increasing the work allocated to household chores and caring for children and other family members, such as the elderly, disabled or sick. Hence, this may increase exposure to domestic violence. Similarly, according to the outside option, women spend more time in the labour market and increase their salary, which empowers them and consequently increases their bargaining power and lowers the incidence of domestic violence.

Finally, women in urban areas are less likely to experience psychological and sexual violence from their husbands than their counterparts in rural areas, while we find insignificant estimates in the physical violence regression. This finding can be explained by the fact that the wives in our sample report lower conservative values and gender role attitudes, are more educated and earn more. We should note that we consider female wages as predicted from the Heckman selection model in Table 3. However, including only the women with observed wages, the concluding remarks remain the same.

5.3 Labour Supply Regressions and Cost of Gender-Based Violence

In Panel A of Table 5, we present the estimated coefficients of the labour supply regressions (1)-(2), and in Panel B, we report the sharing rules. Furthermore, panels A1-A3 and B1-B3 present the regressions for each type of violence. Interestingly, all regressions show that the wife's workdays are negatively related to her and her husband's earnings. We observe the same for the husbands, where male and female wages are negatively related to husbands' labour supply. This finding

shows evidence against the income-pooling property, which assumes that an increase of one euro to the family income should have the same effect on spousal behavior, no matter who earned that money. Thus, the estimates in Table 2 reject the unitary model because they reject the income pooling property.

Regarding the interaction of spouses' wages, we find a positive relationship between male and female labour supply. Regarding household non-labour income, we see the opposite results. In all regressions, non-labour income is negatively related to the female labour supply but is positive in the male labour supply. In the case of the wives, an increase in non-labour income by 1 Egyptian pound decreases their labour supply by 0.6 days in the case of physical and psychological violence regressions and by 0.7 days in the sexual violence regression. In contrast, an increase in the non-labour income by 1 Egyptian pound increases the male labour supply by 0.48 to 0.55 days. We should recall that the survey records the working days per year, not hours per day, days per week, or months.

Regarding educational attainment, it is interesting that female education is positively associated with the female labour supply and negatively associated with the male labour supply. We find the inverse situation for male education. We should highlight that while the education level is a categorical variable in Table 3 and the results of the Heckman selection model, in Table 5, we define as one those who have completed above intermediate, an undergraduate or a postgraduate degree and 0 otherwise, or those who have completed primary, preparatory or secondary school.

Focusing on the distribution factors, we find a negative association between female labour supply, the difference in spouses' ages, gender role attitudes and violence. Thus, these distribution factors reduce the female labour supply while increasing the male labour supply, implying that women's bargaining power reduces. However, we demonstrate an insignificant association between violence and male labour supply, but violence affects only women's labour supply negatively. Moreover, the difference in spouses' ages is negligible in husbands' labour supply regressions.

On the contrary, we find a positive relationship between female asset ownership and female labour supply but a negative association with the male labour supply, even though we found no correlation in Table 2. In this case, female asset ownership increases the female labour supply by 0.24 to 0.35 days per year and reduces the male labour supply by 0.5 to 0.6 days per year. According to the *Hansen J statistic test*, we do not reject the null hypotheses of the no-endogeneity and accept the validity of the instruments employed in the empirical work. In particular, we report the *Chi-square* values for 102 degrees of freedom and compare them with the critical value of *Chi-square*, which is 126.573 at the 95% confidence level. The chi-square values range between 98 and 111 and are lower than the critical Chi-square value, implying that we cannot reject the null hypothesis. We reach the same conclusion if we consider the *p-values*, which are 0.2440, 0.5884 and 0.4269, respectively, in the physical, psychological, and sexual violence regressions and are lower than the 5% and 1%.

Next, we present the sharing rules in panel B, which depicts the effect of a marginal change in one variable on the non-labour income accruing to the wife following sharing. When we consider the physical violence regression in panel B1, for an increase in wage by 1 pound, women transfer 0.28 pounds to their partner, while men transfer 0.15 to their wives. We find higher values of the sharing rules in the regressions of psychological and sexual violence. Specifically, women transfer around

0.35 pounds of their additional wage to their partner, while husbands share approximately 0.19 pounds. The findings show that women share a larger fraction of their income than men and, thus, behave more altruistically. Moreover, the results highlight the importance of the type of domestic violence explored. In particular, we observe that women's sharing rule, and thus, the bargaining power is lower in the physical violence regressions, as the men transfer less of the amount to their spouse than we found in the regressions of psychological and sexual violence. Regarding the non-labour income, the sharing rule ranges between 0.62 in the psychological violence regression to 0.72 in the physical violence regression. This finding shows that a 1 Egyptian pound increase in the household non-labour income will increase the wife's non-labour income by 0.62 to 0.72 pounds or by 62 to 72 piastres, or ersh, which is equivalent to one-hundredth of the pound.

The sharing rules of distribution factors and, in particular, the difference in ages, gender role attitudes and violence are negative, indicating that women are losing or transferring their income to their husbands. If we consider the average female wage rate in Table 1, then the age difference reduces the female labour supply by 0.0125 days per year in the physical violence regression or by 124 pounds per year. We derive similar results from the other violence regressions. If we consider gender role attitudes, the cost of wage loss is 375 pounds per year in the physical violence regression and around 230 pounds in the psychological and sexual violence regressions. The third distribution factor and most important is the experience of domestic violence. For instance, the sharing rule for women who have experienced physical violence is -0.2550 and taking the annual average wage of 9,878 in Table 1, this type of violence results in a wage loss of around 2,500 pounds per year compared to the wives who have not experienced physical violence. The costs are lower for those who have experienced sexual violence at 1,960 pounds, followed by psychological violence at 1,720. On the contrary, asset ownership increases the bargaining power of women and the income for the wives who own an asset or property increases their income by 3,260 more than those with no ownership.

In Table 6, we repeat the GMM estimates for the labour supply equation system of Table 5, excluding education since it can be endogenous (Angrist and Krueger, 1991). While the estimated coefficients differ from those in Table 5, the main concluding remarks regarding the sharing rule and the costs of domestic violence remain the same.

6. Discussion

The findings of this study have various implications. First, the labour supply estimates are compatible with the household collective model. This implies that we reject the unitary model, which assumes the household behaves as a single unit. Still, the results suggest that Egyptian households behave cooperatively. The results are consistent with previous studies where household members' decisions do not depend only on their own characteristics but also on their partner's characteristics, such as wage, age, education, and perception of gender role attitudes (Chiappori, 1988, 1992, Chiappori et al., 2002; Attanasio and Lechene, 2002; Arias et al., 2004; Blundell et al., 2007; Browning et al., 1994, 2009; Hendy and Sofer, 2010; Rapoport et al., 2011; Menon and Perali, 2012; Cherchye et al., 2015; Chavas et al., 2018; Giovanis and Ozdamar, 2019; Molina et al., 2022). For instance, Molina et al. (2022) found that women in Spanish households behave more altruistically than men, as shown in this study. Second, we found that education plays a significant role in the female labour supply. Previous studies have found that education can be protective against abuse (Garcia-Moreno et al., 2006; Amegbor and Rosenberg, 2019). This finding can be

explained by the fact that educated women are more likely to participate in the labour market and have more employment opportunities that enhance their bargaining and decision-making power. Therefore, policies and strategies encouraging girls' education may reduce the education gender gap and constrict the control of men.

Third, the findings highlight the role of gender role attitudes and domestic violence in women's bargaining power. While we have not explored the role of laws, it would be critical to investigate in Egypt and the MENA region in general whether women's bargaining and decision-making power can be strengthened with the design and enforcement of laws against domestic violence. Previous research has demonstrated that these regulations and laws are vital for preventing violence against women, protecting them, and promoting their labour market participation. (Ouedraogo and Stenzel, 2021; Dugan, 2022). On the other hand, the results showed that female asset ownership enhances women's bargaining power. This finding may indicate that asset ownership can signal sufficient economic independence, discourage domestic violence, and increase the female labor supply.

Evidence from countries with significantly increasing women's labour force participation rates over the past half century shows that this rise has been concurrent with widespread change in views on the acceptability and consequences of women's employment (Bolzendahl and Myers, 200). This positive relationship between women's work and egalitarian gender attitudes is significant from a policy perspective because it is mutually reinforcing. Because of the region's low labour force participation rates, it is vital to understand the dynamics and factors that influence women's participation in Egypt and other MENA countries and how attitudes around gender roles are shifting. Our study shows that more egalitarian gender role attitudes and female ownership are critical factors that increase female empowerment through labour market supply, lead to a more equitable distribution of household income and resources, and are negatively correlated to IPV.

Some theoretical frameworks, such as the relative resource and bargaining models, explain how couples decide how to divide labour market supply and housework by viewing it as a free market wherein partners trade off their respective skills and preferences (McElroy and Horney 1981; Blair and Lichter, 1991; Onozaka and Onozaka, 2019). Each member of the household bargains for a share of the household chores based on the monetary resources they contribute to the household, such as labour income. Thus, the wife's ability to bargain for a more equitable distribution of housework increases as her relative economic resources do (Bittman et al., 2003; Greenstein, 2000; Onozaka and Hafzi, 2019). The study's findings suggest that laws and regulations that increase women's access to ownership in an equitable, transparent, and beneficial way may also increase women's negotiating power within the household. Equal rights in the household and the workplace are essential to female empowerment, and programmes provided at a young age that encourage egalitarianism can pave the way for this.

However, the analysis has certain drawbacks. The first limitation is that the empirical research relied on cross-sectional data. On the one hand, this may imply that our results represent correlation, even though we have used instrumental variables. Second, and more importantly, using cross-sectional data, the results are static, and we cannot perform dynamic analysis to explore the response of spouses to economic environment changes. Another limitation is that we have not examined whether the respondent had psychological or physical injuries following the violence. While the survey records this information, the analysis will rely only upon those who have

experienced domestic violence. More specifically, we could have limited the sample only to those who have been victims of domestic violence and then investigated the effect of injuries on the sharing rule—in particular, comparing those with injuries and those with no injuries. Other information recorded in the survey is whether the victim has received any health treatment and the money she spent. However, the number of respondents receiving treatment is minimal, which does not allow for robust analysis, and highlights the possibility that women may prefer not to receive these types of services.

7. Conclusions

The results show that the unitary model fails to meet the criterion of individualism, and the collective model is more appropriate, where the decision-making and empowerment of household members are not solely determined by their utility functions. Still, their choices are also influenced by the characteristics of the other household members. This assumption can be critical to policymaking, especially regarding welfare indicators and policies targeting the reduction of inequalities and poverty. This is also the case of the domestic violence women face from their partners, which can negatively affect their participation in the labour market, and they may experience absenteeism in the workplace and loss in productivity and wages.

The findings may provide some practical conclusions. First, the collective model can serve as a guide on policy evaluation, such as cash transfers, and whether the wife, husband or children should receive them or should we treat the household as a unit. Second, the results suggest that intra-household behavior is asymmetric. More specifically, even though we found similar transfers from the extra wage increases, women behave slightly more altruistically than men. Third, we found that domestic violence and difference in spouses' age negatively affect women's sharing rule and bargaining power, but there is no influence on men.

Regarding gender role attitudes, we found that women with more conservative values present lower bargaining power. One of the most effective ways to reduce poverty and inequality and promote sustainable development is through gender inequality, the advancement of women's rights and their empowerment (IMF, 2013). Policies can be valuable for women to realise their full potential and participate in economic activities. In particular, enacting policies promoting women's employment and education, eliminating labour market inefficiencies, designing mechanisms that prevent female domestic violence, and providing services to women who have experienced such abuse.

Another aspect that we have not explored is whether male unemployment inflicts violence on women. Moreover, the paper has not investigated the impact of domestic violence on female unemployment or labour market participation. Nevertheless, the study aimed to employ a standard intra-household collective model for married couples and highlight the inequalities in sharing rules and bargaining power influenced by gender role attitudes and domestic violence. Therefore, future studies may further investigate and answer these research questions.

Furthermore, the study has not thoroughly explored the theories discussed in the literature review, such as whether the increase in women's income has reduced husbands' economic stress and, consequently, domestic violence or whether outside option enhances women's bargaining power. Similarly, we have not examined the instrumental violence and Male Backlash theories, arguing that the husband uses violence as a bargaining tool to extract resources from the wife.

Finally, another aspect that we could have explored is, apart from the participation in the labour market and household chores, the time spent on housework chores, such as cleaning, ironing, shopping, and caring for children. Nevertheless, we propose this in future studies. Overall, additional surveys should be conducted in Egypt and other countries of the MENA region worldwide, recording information about spouses' wages, hours or days of work, and additional variables required to develop and estimate collective household models.

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Table 1. Summary statistics for married couples in Egypt

Panel A: Spouses characteristics				
Variables	Males	Females	T-statistic	P-value
Annual Wage in Egyptian	20,016.12 (12,401.83)	9,878.694 (18,056.40)	32.805	0.000
Age	45.897 (11.973)	39.123 (10.984)	48.273	0.000
Education				
Primary	0.2035 (0.4025)	0.1994 (0.3996)	0.8227	0.4107
Preparatory	0.1202 (0.3252)	0.1250 (0.3306)	-1.2032	0.2289
Secondary	0.4066 (0.4912)	0.4208 (0.4937)	-2.3732	-0.0176
Above Intermediate	0.0527 (0.2233)	0.0464 (0.2102)	2.4126	0.0158
University Degree	0.2065 (0.4047)	0.1988 (0.3991)	1.5811	0.1139
Postgraduate Studies and Higher	0.0105 (0.1021)	0.0096 (0.0976)	0.7606	0.4469
Annual Working Days	300.206 (68.698)	253.543 (106.623)	17.638	0.000
Panel B: Incidence of Violence				
Violence	Yes	No		
Physical	42.79	57.21		
Psychological	31.13	68.87		
Sexual	12.03	87.97		
Panel C: Household characteristics				
Variables	Average	Standard Deviation	Minimum	Maximum
Household Size	4.649	1.6411	1	12
Urban Area	0.4273	0.4947	0	1

Notes: Standard Deviation within the brackets, wage rates and labour supply are expressed on annual basis.

Table 2. Correlation matrix

	Physical violence	Psychological violence	Sexual violence	Female Wage	Male Wage	Female Labour Supply	Male Labour Supply	Female Age	Male Age	Gender Roles	Female Asset Ownership	Female Education
Psychological violence	0.6674*** (0.000)											
Sexual violence	0.3876*** (0.000)	0.3891*** (0.000)										
Female Wage	-0.0301*** (0.0012)	-0.0448*** (0.000)	-0.0087 (0.3499)									
Male Wage	-0.0360*** (0.0001)	-0.0485*** (0.000)	0.0083 (0.3757)	0.1211*** (0.000)								
Female Labour Supply	-0.0223*** (0.000)	-0.0209*** (0.000)	-0.0095*** (0.0004)	-0.0698*** (0.000)	-0.1305*** (0.0051)							
Male Labour Supply	-0.0716*** (0.000)	-0.0668*** (0.000)	-0.0328*** (0.0009)	0.0423*** (0.0002)	0.0395*** (0.018)	0.3172*** (0.000)						
Female Age	-0.0497*** (0.000)	-0.0320*** (0.0001)	-0.0386*** (0.000)	0.4867*** (0.000)	0.0011 (0.9898)	0.0191 (0.6420)	0.0417*** (0.000)					
Male Age	-0.0489*** (0.000)	-0.0381*** (0.0001)	-0.0431*** (0.000)	0.4382*** (0.000)	-0.0019 (0.8425)	0.0433 (0.2932)	0.0356*** (0.0003)	0.8943*** (0.000)				
Gender Roles	0.1269*** (0.000)	0.1389*** (0.000)	0.0988*** (0.000)	-0.0238** (0.0105)	-0.1093*** (0.000)	-0.0515** (0.0107)	-0.1014*** (0.000)	0.0331*** (0.000)	0.0410*** (0.000)			
Female Asset Ownership	-0.0145* (0.0674)	-0.0066 (0.4066)	-0.0360*** (0.000)	-0.0980*** (0.000)	-0.0336*** (0.0004)	0.0447 (0.2776)	-0.0121 (0.2213)	-0.0628*** (0.000)	-0.0613*** (0.000)	0.0045 (0.5709)		
Female Education	-0.1055*** (0.000)	-0.1320*** (0.000)	-0.0317*** (0.000)	0.0318** (0.0006)	0.2324*** (0.000)	0.0629 (0.2509)	0.1304*** (0.000)	-0.1236*** (0.000)	-0.1596*** (0.000)	-0.1615*** (0.000)	-0.0683*** (0.000)	
Male Education	-0.1158*** (0.000)	-0.1407*** (0.000)	-0.0445*** (0.000)	0.1125*** (0.000)	0.2460*** (0.000)	0.0321 (0.5279)	0.1572*** (0.000)	-0.0706*** (0.000)	-0.0695*** (0.000)	-0.1704*** (0.000)	-0.0592*** (0.000)	0.6036*** (0.000)

P-values within the brackets, ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 3. Heckman selection model for female wages

VARIABLES	Participation Equation	Wage Equation
Female Age	0.2103*** (0.0217)	0.0201*** (0.0034)
Female Age Squared	-0.0021*** (0.0002)	
Male Age	0.0410 (0.0200)	
Male Age Squared	-0.0005*** (0.0002)	
Female Education Level (reference=Primary)		
Female Education Level (Preparatory)	-0.0986 (0.1107)	0.2780 (0.1748)
Female Education Level (Secondary)	0.8322*** (0.0744)	-0.0928 (0.1276)
Female Education Level (Above Intermediate)	1.1624*** (0.0968)	-0.0054 (0.1622)
Female Education Level (University Degree)	1.7309*** (0.0851)	0.2785*** (0.0731)
Female Education Level (Postgraduate Studies and Higher)	2.3531*** (0.1579)	0.2974*** (0.1049)
Male Education Level (reference= Primary)		
Male Education Level (Preparatory)	-0.0894 (0.0887)	
Male Education Level (Secondary)	0.0369 (0.0674)	
Male Education Level (Above Intermediate)	0.0791 (0.0898)	
Male Education Level (University Degree)	0.0591 (0.0749)	
Male Education Level (Postgraduate Studies and Higher)	0.2180** (0.1036)	
Household Non-Labour Income	-0.0804 (0.0598)	
Household Size	-0.0698*** (0.0149)	
Urban Area	0.1017 (0.0706)	0.1048 (0.7090)
Observations	10,482	
Wald chi-square statistic		521.70 [0.000]
Inverse Mills Ratio		-0.0310 (0.1088)

Standard errors within brackets, p-values within square brackets, *** and ** denote significance at the 1% and 5% level.

Table 4. Logit models for determinants of domestic violence

VARIABLES	DV: Physical Violence	DV: Psychological Violence	DV: Sexual Violence
Wage gap (Log Differences of Male-Female Wages)	0.0515** (0.0226)	0.0482* (0.0263)	0.0057 (0.0499)
Age Difference	-0.0165** (0.0065)	-0.0075 (0.0061)	-0.0189* (0.0102)
Female Education Level (reference=Primary)			
Female Education Level (Preparatory)	-0.0770 (0.1035)	-0.0265 (0.1050)	0.0480 (0.1472)
Female Education Level (Secondary)	-0.2708*** (0.0897)	-0.1331 (0.0885)	-0.0191 (0.1226)
Female Education Level (Above Intermediate)	-0.6502*** (0.1606)	-0.1914 (0.1458)	-0.2444 (0.2286)
Female Education Level (University Degree)	-0.7013*** (0.1268)	-0.3488*** (0.1208)	-0.0722 (0.1751)
Female Education Level (Postgraduate Studies and Higher)	-0.5598* (0.2847)	-0.1801 (0.3064)	-0.2550 (0.5335)
Male Education Level (reference= Primary)			
Male Education Level (Preparatory)	-0.1402 (0.1085)	-0.2202** (0.1089)	-0.0880 (0.1552)
Male Education Level (Secondary)	-0.3679*** (0.0888)	-0.3118*** (0.0880)	-0.2768** (0.1251)
Male Education Level (Above Intermediate)	-0.2570* (0.1395)	-0.3553** (0.1375)	-0.1171 (0.1850)
Male Education Level (University Degree)	-0.6020*** (0.1145)	-0.5601*** (0.1105)	-0.3154* (0.1606)
Male Education Level (Postgraduate Studies and Higher)	-0.4147* (0.2261)	-0.6541** (0.2813)	-0.2968 (0.4733)
Household Non-Labour Income	-0.1625 (0.1681)	-0.5536*** (0.1924)	-0.4251 (0.3852)
Household Size	0.1189*** (0.0218)	0.1081*** (0.0215)	0.0616** (0.0299)
Gender Role Attitudes	0.2691*** (0.0377)	0.2513*** (0.0403)	0.3261*** (0.0413)
Female Asset Ownership	-0.2405** (0.1102)	-0.2860** (0.1241)	-0.4245*** (0.1351)
Urban Area	0.1489 (0.1180)	-0.1131* (0.0627)	-0.2509** (0.1090)
Observations	7,834	7,834	7,834
Wald chi-square statistic	1,072.27 [0.000]	1,042.41 [0.000]	843.75 [0.000]

Standard errors within brackets, p-values within square brackets, ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 5. GMM estimates of the labor supply equations

Variables	Panel A: GMM Estimates					
	Panel A1: Physical Violence		Panel A2: Psychological Violence		Panel A3: Sexual Violence	
	Wife	Husband	Wife	Husband	Wife	Husband
Log of female wage $\ln w_f$	-1.1667** (0.5860)	-2.4631** (0.9971)	-1.6429*** (0.5791)	-1.9565** (0.8839)	-2.0535*** (0.6591)	-2.4101*** (0.9137)
Log of male wage $\ln w_m$	-0.9606* (0.5097)	-2.0012** (0.7795)	-1.2313** (0.5029)	-1.7229** (0.7772)	-1.6311*** (0.5706)	-2.1301*** (0.8038)
Interaction of spouse' wages $\ln w_m \times \ln w_f$	0.1392* (0.0801)	0.3145** (0.1227)	0.2012** (0.0791)	0.2721** (0.1209)	0.2568*** (0.0901)	0.3356*** (0.1250)
Household Non-labour income (y) /1000	-0.6061*** (0.0891)	0.5168*** (0.1427)	-0.5949*** (0.0873)	0.4839*** (0.1369)	-0.8135*** (0.1065)	0.5462*** (0.1452)
Difference in Age	-0.0104** (0.0046)	0.0088 (0.0076)	-0.0141** (0.0062)	0.0084 (0.0073)	-0.0135*** (0.0051)	0.0072 (0.0051)
Female Education	0.2367*** (0.0487)	-0.2343*** (0.0795)	0.2004*** (0.0479)	-0.2513*** (0.0776)	0.1731*** (0.0517)	-0.2173*** (0.0789)
Male Education	-0.1205*** (0.0421)	0.3331*** (0.0702)	-0.1440*** (0.0422)	0.3494*** (0.0701)	-0.0861** (0.0435)	0.3170*** (0.0707)
Gender Role Attitudes	-0.0320** (0.0144)	0.0464** (0.0232)	-0.0221** (0.0102)	0.0405* (0.0233)	-0.0259* (0.0156)	0.0482** (0.0240)
Female Asset Ownership	0.2768*** (0.0701)	-0.6641*** (0.1168)	0.3575*** (0.0692)	-0.6352*** (0.1144)	0.2380*** (0.0749)	-0.6927*** (0.1195)
Violence	-0.2129*** (0.0169)	-0.0236 (0.0309)	-0.1659*** (0.0124)	-0.0346 (0.0230)	-0.2446*** (0.0270)	-0.0051 (0.0082)
No. observations	6,277		6,277		6,277	
Hansen's J statistic Chi-Square Test	111.524 [0.2440]		98.188 [0.5884]		103.978 [0.4269]	
Panel B: Sharing Rules for Wife						
	Panel B1: Physical Violence		Panel B2: Psychological Violence		Panel B3: Sexual Violence	
w_f	0.2804** (0.1232)		0.3364*** (0.0425)		0.3307*** (0.0402)	
w_m	0.1530** (0.0676)		0.1882*** (0.0332)		0.1919*** (0.0313)	
Non-labour income	0.7260*** (0.1629)		0.6243*** (0.1625)		0.6605*** (0.1330)	
Difference in Age	-0.0125** (0.0058)		-0.0149** (0.0063)		-0.0110** (0.0043)	
Gender Role Attitudes	-0.0384* (0.0208)		-0.0232** (0.0107)		-0.0211* (0.0114)	
Female Asset Ownership	0.3316*** (0.1201)		0.3752*** (0.1403)		0.1933** (0.0769)	
Violence	-0.2550*** (0.0638)		-0.1741*** (0.0483)		-0.1986*** (0.0457)	

Standard errors within brackets, p-values within square brackets, ***, ** and * denote significance at the 1%, 5% and 10% level.

Table 6. GMM estimates of the labor supply equations excluding education

Variables	Panel A: GMM Estimates					
	Panel A1: Physical Violence		Panel A2: Psychological Violence		Panel A3: Sexual Violence	
	Wife	Husband	Wife	Husband	Wife	Husband
Log of female wage $\ln w_f$	-1.3448** (0.5791)	-2.2358*** (0.8161)	-1.8845*** (0.5568)	-2.1657*** (0.8117)	-2.9163*** (0.6316)	-2.6256*** (0.8365)
Log of male wage $\ln w_m$	-1.1395** (0.5086)	-2.1495*** (0.7726)	-1.4228*** (0.4883)	-1.8825*** (0.7092)	-1.9799*** (0.5526)	-2.3114*** (0.7390)
Interaction of spouse' wages $\ln w_m \times \ln w_f$	0.2287*** (0.0792)	0.3679*** (0.1116)	0.2705*** (0.0762)	0.3579*** (0.1111)	0.3699*** (0.0863)	0.4080*** (0.1144)
Household Non-labour income (y) /1000	-0.6816*** (0.0905)	0.5515*** (0.1406)	-0.6590*** (0.0876)	0.5368*** (0.1435)	-0.8371*** (0.1055)	0.5827*** (0.1369)
Difference in Age	-0.0092* (0.0046)	0.0075 (0.0064)	-0.0100* (0.0057)	0.0075 (0.0065)	-0.0098* (0.0052)	0.0063 (0.0064)
Gender Role Attitudes	-0.0333** (0.0149)	0.0592*** (0.0204)	-0.0215** (0.0101)	0.0536*** (0.0203)	-0.0263** (0.0111)	0.0567*** (0.0212)
Female Asset Ownership	0.3031*** (0.0697)	-0.6208*** (0.1058)	0.4078*** (0.0686)	-0.6085*** (0.1049)	-0.2591*** (0.0738)	-0.6487*** (0.1086)
Violence	-0.2348*** (0.0167)	-0.0132 (0.0098)	-0.1767*** (0.0121)	-0.0346 (0.0230)	-0.2480*** (0.0265)	-0.0365 (0.0292)
No. observations	6,277		6,277		6,277	
Hansen's J statistic Chi-Square Test	113.091 [0.2775]		96.934 [0.5052]		92.281 [0.5576]	
	Panel B: Sharing Rules for Wife					
	Panel B1: Physical Violence		Panel B2: Psychological Violence		Panel B3: Sexual Violence	
w_f	0.2992** (0.1351)		0.3402*** (0.0472)		0.3727*** (0.0442)	
w_m	0.1477** (0.0628)		0.1839*** (0.0383)		0.2086*** (0.0354)	
Non-labour income	0.7077*** (0.1732)		0.6206*** (0.1517)		0.6129*** (0.1315)	
Difference in Age	-0.0090* (0.0048)		-0.0094* (0.0052)		-0.0072* (0.0037)	
Gender Role Attitudes	-0.0331** (0.0153)		-0.0202* (0.0104)		-0.0192** (0.0092)	
Female Asset Ownership	0.3514*** (0.0985)		0.3829*** (0.1018)		0.2044*** (0.0671)	
Violence	-0.2334*** (0.0612)		-0.1664*** (0.0319)		-0.1815*** (0.0344)	

Standard errors within brackets, p-values within square brackets, ***, ** and * denote significance at the 1%, 5% and 10% level.

Appendix A. Theoretical Framework

Under the separability assumption on individuals' preferences, the Pareto efficiency implies that the intra-household collective process can be interpreted as a two-stage process (Chiappori 1992; Chiappori et al., 2002). In the first stage the spouses share the non-labour income according to an unobservable and exogenous sharing rule that reflects the bargaining power of each member in the household. In the second stage once the household non-labour income has been allocated between the members. The model assumes that households consist of two spouses, $i = f, m$, denoting respectively female and male with individual utility:

$$U_i = U_i(1 - h_i, C_i, \mathbf{z}) \quad (\text{A1})$$

Where h_i represents the paid work time, and leisure is defined as $l_i = T - h_i$, where T is the total time. C_i denotes the consumption of a Hicksian good with unitary price, and \mathbf{z} is a vector of preference factors. According to the hypotheses of the model, the allocation of the household resources is determined by the spouses' bargaining power in household decision-making. Then, the Pareto weight, which is unobserved but depends on observable factors is:

$$\mu = \mu(w_f, w_m, y, \mathbf{z}, s) \in (0,1) \quad (\text{A2})$$

w and y denote the wage and non-labour household income respectively, and s represents the set of distribution factors. Then the household solves the following program:

$$\max_{\{C_i, h_i\}} \mu U_f + (1 - \mu) U_m \quad (\text{A3})$$

Subject to the budget constraint:

$$w_f h_f + w_m h_m + y = C_f + C_m \quad (\text{A4})$$

As we mentioned earlier, the maximization problem A3 is equivalent to a decentralised two-stage process, where first, spouses bargain the allocation of household income according to a sharing rule $\varphi = \varphi(\mu)$, such that female agent f receives $\varphi_f = \varphi$ and male agent receives $\varphi_m = y - \varphi$. For more detailed demonstration see Chiappori (1992) and Chiappori et al. (2002). Each spouse then maximizes the following program.

$$\max_{\{C_i, l_i\}} U_i(C_i, l_i, \mathbf{z}) \quad (\text{A5})$$

Subject to the budget constraint:

$$C_i = h_i w_i + \phi_i(\mu) \quad (\text{A6})$$

In constraint (A6) ϕ_i denotes i 's non-labour market income and

$$\phi_f + \phi_m = y \quad (\text{A7})$$

As we described earlier ϕ_f is a function of w_f, w_m, y, s . Therefore, the shares will be a function of wages, non-labour income, preferences and distribution factors and as a result, for interior solutions, the total labour supplies will have the form:

$$h^f = h^f(w_f, \phi(w_f, w_m, y, s, \mathbf{z}) \mathbf{z}) \quad (\text{A8})$$

$$h^m = h^m(w_m, y - \phi(w_f, w_m, y, s, \mathbf{z}) \mathbf{z}) \quad (\text{A9})$$

In equation A8, we present female labour supply which is a function of the wage rate, the share, which is a function spouses' wages, the non-labour income the distribution and preference factors.

Appendix B. Differentiation of the labour supply equations and sharing rule

Considering the labour supply functions (1)-(2) in the main text we define:

$$A = \frac{h_{w_m}^f}{h_y^f} = \frac{f_2 + f_4 \ln w_f}{f_3 w_m} \quad (\text{B1})$$

$$B = \frac{h_{w_m}^m}{h_y^m} = \frac{m_1 + m_4 \ln w_m}{m_3 w_f} \quad (\text{B2})$$

$$C = \frac{h_s^f}{h_y^f} = \frac{f'}{f_3} \quad (\text{B3})$$

$$D = \frac{h_s^m}{h_y^m} = \frac{m'}{m_3} \quad (\text{B4})$$

In this study we assume more than one distribution factor described in the text. Thus, in B3 and B4 we define f' and m' as the estimated coefficients of distribution factors described in the paper. The partial derivatives with respect to non-labour income, distribution factor and wages will be:

$$\frac{\partial \phi}{\partial y} = \frac{D}{D - C} \quad (\text{B5})$$

$$\frac{\partial \phi}{\partial s} = \frac{CD}{D - C} \quad (\text{B6})$$

$$\frac{\partial \phi}{\partial w_m} = \frac{AD}{D - C} \quad (\text{B7})$$

$$\frac{\partial \phi}{\partial w_f} = \frac{BC}{D - C} \quad (\text{B8})$$

From the Hotelling's lemma the sharing rules are: (Chiappori et al., 2002):

$$\phi_y = \frac{D}{D - C} = \frac{f_3 m_4}{\Delta} \quad (\text{B9})$$

$$\phi_s = \frac{CD}{D - C} = \frac{m_4 f'}{\Delta} \quad (\text{B10})$$

$$\phi_m = \frac{AD}{D - C} = \frac{m_4 f_2 + f_4 \ln w_f}{\Delta w_m} \quad (\text{B11})$$

$$\phi_f = \frac{BC}{D - C} = \frac{f_4 m_1 + m_4 \ln w_m}{\Delta w_f} \quad (\text{B12})$$

Where $\Delta = f_3 m_4 - m_3 f_4$. Solving the system of differential equations B9-B12, we derive the sharing rule equation:

$$\phi = \frac{1}{\Delta} (m_1 f_4 \ln w_f + f_2 m_4 \ln w_m + f_4 m_4 \ln w_f \ln w_m + f_3 m_4 y + f' m_4 s) \quad (\text{B13})$$

As we have highlighted earlier, and in the main text, we consider more than one distribution factor, and thus the sharing rule is defined as $f' m_4 s / \Delta$, where f' represents the set of the estimated coefficients of the distribution factors explored.