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Geunyoung Kim April 16, 2014

Adultery Laws: The Effect of Legal Sanctions on Marital Investment and Adultery

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Abstract

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According to the New Oxford American Dictionary, adultery is an instance of voluntary sexual intercourse between a married person and a person who is not his or her spouse. This paper models adultery in a two-stage game between a husband and a wife to show whether having legal sanctions against adultery has any impact on reducing the likelihood of adultery. In stage one, the husband simultaneously makes a choice about whether to invest in the marriage and whether to commit adultery while the wife chooses whether to invest in the marriage. The husband and wife's respective choices about investing in the marriage are not known to each other in stage one. In stage two, based on her husband's choice to cheat or to stay committed to the marriage, the wife determines whether to get a divorce or not. From the model, we observe that adultery occurs if the benefits of adultery compensate for the husband's moral cost of committing adultery and any legal sanctions against adultery. We also find that legal sanctions and morality work towards the same end to reduce the probability of adultery when both are present. In cases where legal sanctions are available only when divorce occurs, both the husband and wife's decisions to invest make the husband less likely to commit adultery. Therefore, when legal sanctions against adultery and morality are not present, the marriage-specific investment can be used to reduce the probability of adultery.

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# Chapter 1

# Introduction

Although the legal definition of adultery may vary across different countries, its dictionary definition is stated as "voluntary sexual intercourse between a married person and a person who is not his or her spouse" (New Oxford American Dictionary). Due to the nature of adultery, which involves privacy issues, laws prohibiting adultery - also known as adultery laws - have received significant attention, particularly regarding their legitimacy and necessity.

In the United States, many view adultery laws as a violation of the principles of limited government and an infringement on the individual's freedom, while others see them as a required rule for society to establish order, maintain social ethics, and prevent massive negative externalities on third parties such as children, and on society at large. Due to such discrepancies in opinions about adultery laws, there is no uniform law at the federal level in the US. Even those states that treat adultery as a "crime against marriage" on statute rarely enforce these laws and their punishment schemes vary.

The states that have adultery laws on statute are the following: Alabama (moderate[1]), Arizona (moderate), Florida (moderate), Georgia (mild[2]), Hawaii (moderate), Idaho (moderate), Illinois (severe[3]), Kansas (mild), Maryland (mild), Massachusetts[4] (severe), Michigan(severe), Minnesota (moderate), Mississippi (moderate), Nebraska[5](mild), New Hampshire (severe), New York (moderate), North Carolina (moderate), North Dakota (severe), Oklahoma (severe), Rhode Island (moderate), South Carolina (mild), Texas (mild), Utah

[1]Moderate: class 2 or B misdemeanor, more than 6 months or less than year of imprisonment, alimony.
[2]Mild: class 3 or 3 misdemeanor, grounds for fault-divorce, banned from holding public office.
[3]Severe: class 1 or A misdemeanor, felony, life sentence, more than a year of jail time, $500 or more.
[4]Mass. Gen. Laws ch. 272, 14
[5]Neb. Rev. Stat. 42-351

(severe), Virginia (moderate), West Virginia (mild), and Wisconsin (severe).[6],[7]

In many cases, states initiate the prosecution for adultery, although it is possible for the non-adulterous spouse to initiate the prosecution in some states. To validate the prosecution, the state also has the dual burden of both proving adultery and verifying that at least one of the adulterers is married.

In other countries, legal rules and punishments for adultery vary widely. Some countries including South Korea and Taiwan consider adultery a crime subject to prosecution. According to *The Telegraph*, until recently, Iranians were stoned to death after being convicted of adultery.[8] Adultery is also not a crime in China, but it constitutes grounds for divorce. Many other countries including Denmark (1930), Spain (1978), Switzerland (1990), and Austria (1996) removed criminal punishment for adultery.[9]

Adultery is usually considered a wrongdoing as it involves a breach of trust and deception, causes emotional trauma, and often leads to divorce. Whether it should be considered a crime however, is subject to different perspectives. When adultery laws exist, the government can use its state authority to punish adulterers. The controversy rises from the question of whether the government has such authority. On one hand, some advocate the criminalization of adultery and want adultery laws to be living laws - laws that are actually enforced - because they strengthen the moral values of the community. Advocators of adultery laws also believe that these laws must be put into place because the government is responsible for protecting the marriage institution and keeping social order. Despite these arguments presented by advocates, governments are reluctant to constitute adultery laws for several reasons, such as a high cost of implementation, the possibility of crowding out moral values of the community by placing every subject under the government's judgment, and fear of

[6]EPIS. "Laws on Infidelity and Adultery." EPIS. N.p., n.d. Web. 2 Feb. 2014. <http://www.epis.us/laws_on_infidelity_and_adultery.html>.

[7]"Business Contracts, Consumer Forms, Business Incorporation." ONECLE. N.p., n.d. Web. 13 Feb. 2014. <http://www.onecle.com>.

[8]AFP. "Iran Amends Law on Stoning for Adultery." The Telegraph. Telegraph Media Group, 30 May 2013. Web. 5 Mar. 2014.

[9]Adultery Case. Constitutional Court of Korea. 30 Oct. 2008. Print.

extreme private punishment. In fact, due to these reasons, many countries including Italy (1969), France (1975), Spain (1981), Greece (1983)[10],[11],[12] and others have decriminalized adultery. In the U.S., Colorado (2013) also recently abolished its adultery laws.

The crime of adultery is punished differently in different places but it imposes a uniform cost on all adulterers. For instance, if a government imposes a $10 fine on adulterers, the financial penalty applies to every adulterer equally. On the other hand, moral punishment varies depending on the adulterer's personal level of morality (e.g., high or low). This is the motivation for our study.

Previously, we have addressed some of the points associated with two questions; one, why is adultery immoral and two, should adultery be illegal? If the society wants to reduce the likelihood of adultery and the criminalization of adultery can lower the probability, then adultery should be illegal. However, if the criminalization has no effect on reducing the probability of adultery, then it will not be necessary. Hence, by constructing a two stage game between two players, a husband and a wife, this paper addresses the two part question of whether or not legal rules for adultery reduces the likelihood of adultery, and what other factors can also reduce the probability of adultery. The model includes variables for legal sanctions, morality, and marital investments, whether an increase in the cost of adultery by the addition of legal punishment reduces the likelihood of adultery. In stage one, the husband, a potential adulterer, simultaneously chooses whether to invest in the marriage and whether to commit adultery while the wife simply makes a choice about whether to invest in the marriage. In many cases, if the investment outcomes exceed the cost of investment, which includes spending of income, raising children, and more, they choose to invest. Also, if the benefit the husband receives from committing adultery can compensate for his moral cost of committing adultery, public punishment, and other costs he incurs by committing adultery,

[10]Delmas-Marty, Mireille. The European Convention for the Protection of Human Rights: International Protection versus National Restrictions. Dordrecht: M. Nijhoff, 1992. Print.

[11]Forse, Michel. Recent Social Trends in France, 1960-1990. Frankfurt Am Main: Campus Verlag, 1993. Print.

[12]Dervis, Kemal. The European Transformation of Modern Turkey. Bruxelles: Centre for European Policy Studies, 2004. Print.

he will cheat on his wife.

In stage two, the wife is informed if adultery occurred, and she decides whether to get a divorce or not. The wife's decision about whether to file for a divorce is based on the cost of her husband's and her own investment in the marriage, the remaining amount of investment return after applying adultery-divorce specific depreciation, her moral cost of staying with the adulterous husband, and the benefits she receives from the public punishment. If the wife's moral cost of living with a cheating husband is so high that she cannot live with a cheating husband, then in case of adultery, she chooses to get a divorce. From the model, we observe that legal sanctions for adultery have an influence on the decisions of the husband and wife. More precisely, legal sanctions reduce the likelihood of adultery. Likewise, legal sanctions and personal morality against adultery reinforce each other in reducing the likelihood of adultery. In addition, if the wife's investment outcome is large enough to affect the husband's decision to commit adultery, he is less likely to commit adultery.

The remainder of this paper is structured as follows. In section 2, we summarize existing literature related to adultery and adultery laws and our contribution to it. Then in section 3, we present our basic model with an explanation of the structure of the model and a brief interpretation. In section 4, using the base case, we provide two extensions, and their conditions and respective equilibria. In section 5, we discuss the results from both the basic and extension models and their implications. We will conclude this current study with section 6.

# Chapter 2

# Literature Review

Economists have attempted to address the relationship between adulterous behavior and adultery laws. Rasmusen (2002) examines adultery laws through a model that considers the wife as the non-adulterous spouse who can choose the level of marriage-specific investment and monitoring effort and the husband, the potential adulterer, determines whether to commit adultery or not. Rasmusen argues that adulterous behavior can be deterred through two channels: legal punishment and internal costs for committing adultery. Both the legal penalty and the internal cost of committing adultery reduce the husbands utility, and may prevent him from committing adultery. Furthermore, Rasmusen suggests that in order to achieve efficiency in marriage, public punishment for adultery is required and should have different features depending on the initiator of the punishment, the time of costs transfer, and other factors.

Fair's (1978) model utilizes the concept of individuals' time allocation among work and leisure activities to explain adulterous behavior. He argues that adulterous behavior is closely associated with one's time allocation: one can choose how much time one wants to spend with a paramour and that would determine whether one commits adultery or not. In addition, he describes that one's decision to commit adultery will depend on one's wage rate, the price level, one's non-labor income, the time one spends with one's spouse in the marriage, values of the goods supplied by one's spouse to the marriage, the time one spends with his paramour, and other factors that influence the utility of the marriage and the affair. The motivation underlying Fair's model is that people desire variety in their lives, and an affair simply serves as an extra good that can be consumed to increase one's utility. Hence, an individual will commit adultery when the amount that utility can be increased by

committing adultery is higher than the cost.

Liu (2008) explains how the legal punishment scheme for adultery works and also argues that the mere existence of a legal code does not effectively deter adultery. She suggests that adultery can be deterred effectively in the presence of legal punishment that results in an increase in the adulterers expected loss while the benefits associated with committing adultery remain constant or increase.

This paper is based on Wickelgren's (2009) model, used in the analysis of divorce law, and Cohen's (2002) marriage contract to observe how individuals' behavior related to adultery changes in the presence of adultery laws. According to Shavell (2002), one's morality restricts "bad" acts by making one feel guilty, and promotes "good" acts by positive reinforcement or praise. In other words, the individual's incentive to not commit adultery comes from the internal self. On the other hand, the criminalization of adultery introduces a uniform cost to adulterers' utility. With this in mind, we examine the role of legal sanctions and morality in the choice about committing adultery.

The existing literature shows that the decision to commit adultery does not solely depend on the direct benefits and costs of committing adultery, but on many other factors as previously mentioned. Having the government impose criminal sanctions on adultery may not terminate the behavior. The focus of this paper however, is not on finding ways to effectively deter adultery but on observing how public and private punishment for adultery influence people's choices, and whether adultery laws reduce the probability of adultery. Hence, our discussion remains in observing the relationship between the marital investment choices and morality and criminal sanctions, and between morality and criminal sanctions.

The structure of the base case resembles the one in Rasmusen (2002). However, this paper's main framework is different because it provides an explanation of the effect of adultery laws through a game theoretic model and supports the findings with the conditions that allow certain decisions to be made.

# Chapter 3

# Basic Model

## 3.1 Model

In our basic model, we consider a two-stage game with two players: a husband and a wife. For the purpose of the model, we only allow one of the players to be a potential adulterer. Following the structure of other existing studies, the husband is the potential adulterer. In stage one, the husband simultaneously decides whether to invest in his marriage and whether to commit adultery. Then we let $\alpha_1$ be the probability that the husband chooses to invest and commit adultery, $\alpha_2$ be the probability of his choice of no investment and adultery, $\alpha_3$ the probability of his choice no investment and no adultery, and $\alpha_4$ be the probability of his choice of investment and no adultery. If he chooses to invest, he gains his personal investment outcome (h) while paying the cost of investment ($c_h$). Also, if he chooses to commit adultery, he gets benefits from adultery (a) and incurs associated costs including public punishment (s), his moral cost of committing adultery ($m_h$), and the depreciated amount of the investment outcome (xh, xw). We assume simultaneity of the two choices, the husband's decisions about investment and adultery, to exclude the possible impact of investment choices on adultery. The wife chooses whether to invest in the marriage or not. We let $\beta$ be the probability that the wife chooses to invest. When she chooses to invest, she pays the cost of investment ($c_w$) to get her own investment outcome (w). Their choices about investment are not known to each other in stage one.

In stage two, the wife knows if her husband has cheated on her, and she decides whether to get a divorce or not based on that information. Let $\theta_1$ be the probability that the wife

chooses to divorce if the husband invests and commits adultery and she chooses to invest, $\theta_2$ be the probability that she chooses to divorce if he invests and commits adultery and she does not invest, and $\theta_3$ be the probability of divorce given he has chosen to not invest but to commit adultery and she has chosen to invest. We allow the wife to know the incidence of adultery because it will be known at some point in the marriage, despite a variation in the elapsed time between when adultery actually occurs and when she finds out. If she chooses to divorce, the investment in the marriage depreciates. The depreciation rate depends on whether a divorce has occurred as a result of adultery. If adultery happens, investment outcomes depreciate at x rate while no adultery leads to y rate of depreciation. Due to the method we used to structure the model, if the husband does not commit adultery, then the wife's payoffs for not getting a divorce are always greater compared to the payoffs she gets from getting a divorce. Therefore, she does not choose to divorce if adultery does not happen. On the other hand, if she chooses to not divorce even though the husband committed adultery, she has to pay the cost of living with the adulterous husband ($m_w$).

**Parameters that are included in the basic model are the following:**
h - the husband's investment outcome
w - the wife's investment outcome
$c_h$ - the husband's investment cost
$c_w$ - the wife's investment cost
a - the husband's benefit from committing adultery
s - public punishment for committing adultery
$m_h$ - the husband's moral cost of committing adultery
$m_w$ - the wife's moral cost of staying with an adulterous husband
x - the adultery-divorce specific depreciation rate
y - the no adultery-divorce specific depreciation rate

Before we discuss different scenarios and possible equilibria, we need to make the following general assumptions:

**Assumption 1.** *If $c_h > h$ and $c_w > w$ for the husband and wife respectively, marriage-*

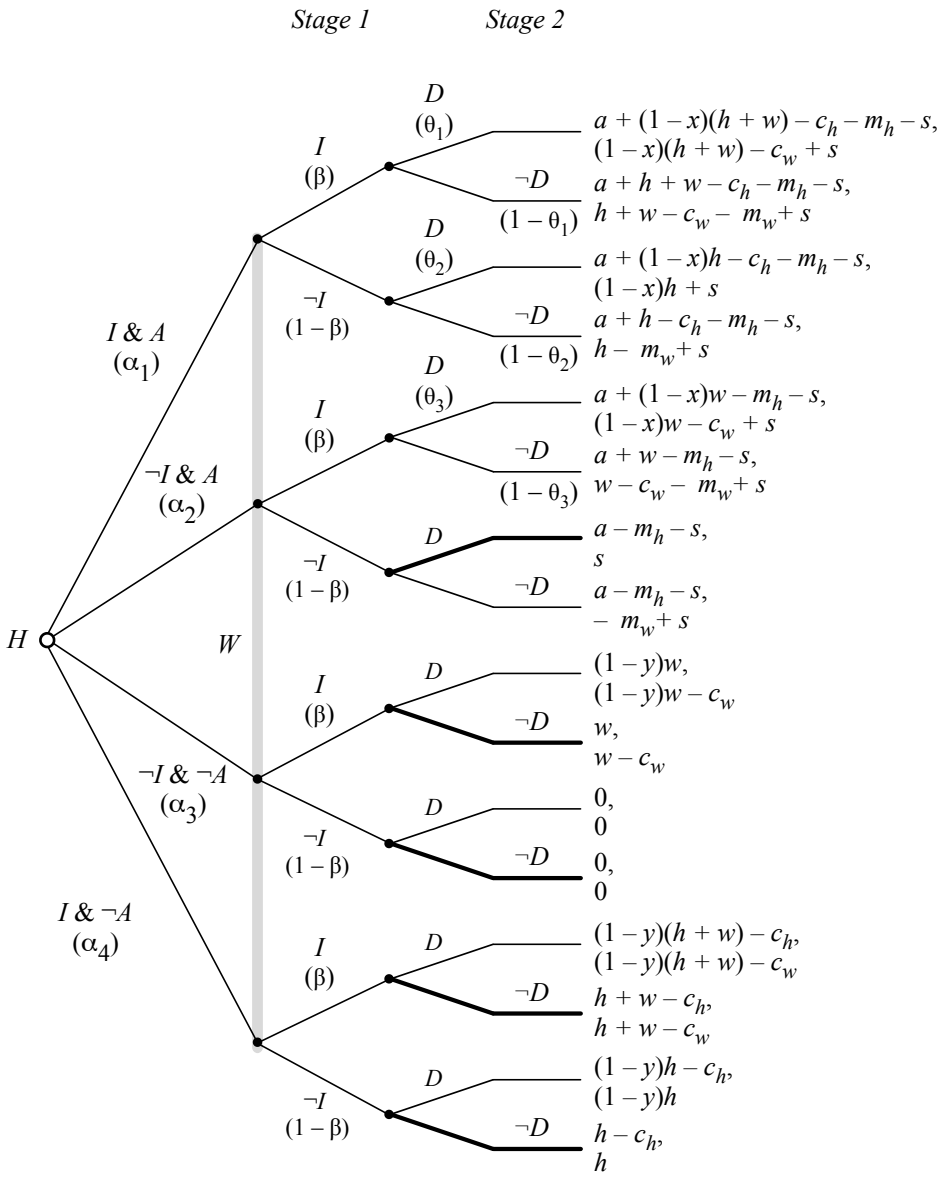


Figure 3.1: Game Tree for Basic Model

*specific investment is not worthwhile.*

**Assumption 2.** *If adultery and divorce occur, the marriage-specific asset depreciates at a rate x.*

**Assumption 3.** *If no adultery is involved but divorce occurs, the marriage-specific asset depreciates at a rate y.*

**Assumption 4.** *All the variables are non-negative.*

## 3.2 Equilibria and Conditions

**For** $m_w > xh + xw, c_w < w$

1. If $c_h > \max\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h > \max\{-xw + a - s, h - c_h - xh - xw + a - s\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h > \max\{-xw + a - s, h - c_h - xh - xw + a - s\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h < \min\{-xw + a - s, h - c_h - xh - xw + a - s\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < \min\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h < \min\{-xw + a - s, h - c_h - xh - xw + a - s\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1, \theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

From the above four conditions, we can see when certain decisions are more likely to happen. When w is large enough to make $c_w$ small enough to satisfy the condition $c_w < w$, the wife

chooses to invest. In addition, as w increases, not only does the wife become more likely to invest, but the husband also becomes less likely to commit adultery to satisfy his moral conditions given in 1 and 2. This is because as w increases, xw also increases when x is fixed, thus making $m_h$ large. On the other hand, if $m_h$ is large, the husband is less likely to invest. For a large s, even for a small $m_h$, it is not worthwhile to commit adultery. Thus the husband is less likely to invest. From these cases, we can see that for a large s, $m_h$ increases, which implies that the husband becomes less likely to commit adultery. Both legal sanctions and morality against committing adultery make the husband less likely to commit adultery and also less likely to invest.

**For** $\max\{xh, xw\} < m_w < xh + xw$**,** $c_w < w$

1. If $c_h > \max\{h + xw - a + m_h + s, h + a - m_h - s\}$, $m_h > a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + xw - a + m_h + s, h + a - m_h - s\}$, $m_h > a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h + xw - a + m_h + s, h + a - m_h - s\}$, $m_h < -xw + a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < \min\{h + xw - a + m_h + s, h + a - m_h - s\}$, $m_h < -xw + a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

**For** $xw < m_w < xh$**,** $c_w < w$

1. If $c_h > \max\{h + xw - a + m_h + s, h + a - m_h - s\}$, $m_h > a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + xw - a + m_h + s, h + a - m_h - s\}$, $m_h > a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

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4. If $c_h < \min\{h + xw - a + m_h + s, h + a - m_h - s\}$, $m_h < -xw + a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

**For** $xh < m_w < xw$**,** $c_w < w$

1. If $c_h > \max\{h - a + m_h + s, h + a - m_h - s\}$, $m_h > \max\{a - s, -h + c_h + a - s\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h - a + m_h + s, h + a - m_h - s\}$, $m_h > \max\{a - s, -h + c_h + a - s\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h - a + m_h + s, h + a - m_h - s\}$, $m_h < \min\{a - s, -h + c_h + a - s\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < \min\{h - a + m_h + s, h + a - m_h - s\}$, $m_h < \min\{a - s, -h + c_h + a - s\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $m_w < \min\{xh, xw\}$**,** $c_w < w$

1. If $c_h > \max\{h, h - a + m_h + s\}$, $m_h > \max\{a - s, -h + c_h + a - s\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h, h - a + m_h + s\}$, $m_h > \max\{a - s, -h + c_h + a - s\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h, h-a+m_h+s\}$, $m_h < \min\{a-s, -h+c_h+a-s\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

4. If $c_h > \min\{h, h-a+m_h+s\}$, $m_h < \min\{a-s, -h+c_h+a-s\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

**For** $m_w > xh + xw, c_w < w - xw$

1. If $c_h > h$, $m_h > -xh - xw + a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > -xh - xw + a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < -xh - xw + a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < h$, $m_h < -xh - xw + a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

**For** $m_w > xh + xw, c_w > w - xw$

1. If $c_h > h - xh$, $m_h > -xh - xw + a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h - xh$, $m_h > -xh - xw + a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h - xh$, $m_h < -xh - xw + a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 0$, $\theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < h - xh$, $m_h < -xh - xw + a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 0$, $\theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

**For** $\max\{xh, xw\} < m_w < xh + xw$**,** $c_w < xh + w - m_w$

1. If $c_h > h + xw$, $m_h > a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h + xw$, $m_h > a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h + xw$, $m_h < a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < h + xw$, $m_h < a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

**For** $xw < m_w < xh$**,** $c_w < xh + w - m_w$

1. If $c_h > h + xw$, $m_h > a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h + xw$, $m_h > a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h + xw$, $m_h < a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

4. If $c_h < h + xw$, $m_h < a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

**For** $xh < m_w < xw$**,** $c_w < xh + w - m_w$

1. If $c_h > h$, $m_h > a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < h$, $m_h < a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $\max\{xh, xw\} < m_w < xh + xw$**,** $c_w > xh + w - m_w$

1. If $c_h > h - xh$, $m_h > -xh + a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h - xh$, $m_h > -xh + a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h - xh$, $m_h < -xh + a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < h - xh$, $m_h < -xh + a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

**For** $xh < m_w < xw$**,** $c_w > xh + w - m_w$

1. If $c_h > h - xh$, $m_h > -xh + a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h - xh$, $m_h > -xh + a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h - xh$, $m_h < -xh + a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < h - xh$, $m_h < -xh + a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $xh < m_w < xw$**,** $c_w < xh + w - m_w$

1. If $c_h > h$, $m_h > a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < h$, $m_h < a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $m_w < \min\{xh, xw\}$**,** $c_w < w - m_w$

1. If $c_h > h$, $m_h > a - s$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > a - s$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < a - s$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

4. If $c_h < h$, $m_h < a - s$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

## 3.3 Summary

For the base case, legal sanctions are available in all cases when adultery occurs. Legal sanctions do not affect the wife's investment decision. Although legal sanctions influence the husband's decision to invest, the relationship between the two is not clear because the sign of the variable for legal sanctions appears in the conditions as negative or positive depending on the cases. However, if legal sanctions appear in the conditions for decisions about adultery, for a given level of husband's morality, they make the husband less likely to commit adultery.

If the husband's moral cost of committing adultery is high enough to satisfy the conditions for no adultery, then he will not commit adultery. Therefore when one, or both of, either the legal sanctions or the husband's moral cost of committing adultery are large, they reduce the likelihood of adultery by making adultery not worthwhile. In addition, the husband's moral cost of committing adultery appears in the conditions for his investment decision. However, the relationship is again not clear due to its alternating signs depending on the cases.

In most cases, the wife makes her choice about investment based on the cost and benefit of her own investment. Also when both the husband and wife's investment outcomes appear in the conditions for the husband's adultery decisions, they make the husband less likely to commit adultery by making adultery not worthwhile. In other words, if both legal sanctions are not present and the potential adulterer's morality level is low, then the non-adulterous spouse can invest in the marriage to reduce the likelihood of adultery.

# Chapter 4

# Two Extensions

## 4.1 Extension I

In this first extension model, everything remains the same as the base case but now we allow legal sanctions to be available only when divorce occurs. In other words, the wife can punish her cheating husband via public punishment only when she is determined enough to get a divorce. If she decides to stay in the marriage, punishing him through legal sanctions is no longer possible.

In terms of payoffs, it means that s will be removed when the wife chooses to not divorce. General assumptions hold same as the base case. In the following, we examine how the change in the model affects two players' decisions.

## 4.2 Conditions and Equilibria for Extension I

**For** $m_w > xh + xw - s$**,** $c_w < w$

1. If $c_h > \max\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h > \max\{-xw + a - s, h - c_h - xh - xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h > \max\{-xw + a - s, h - c_h - xh - xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

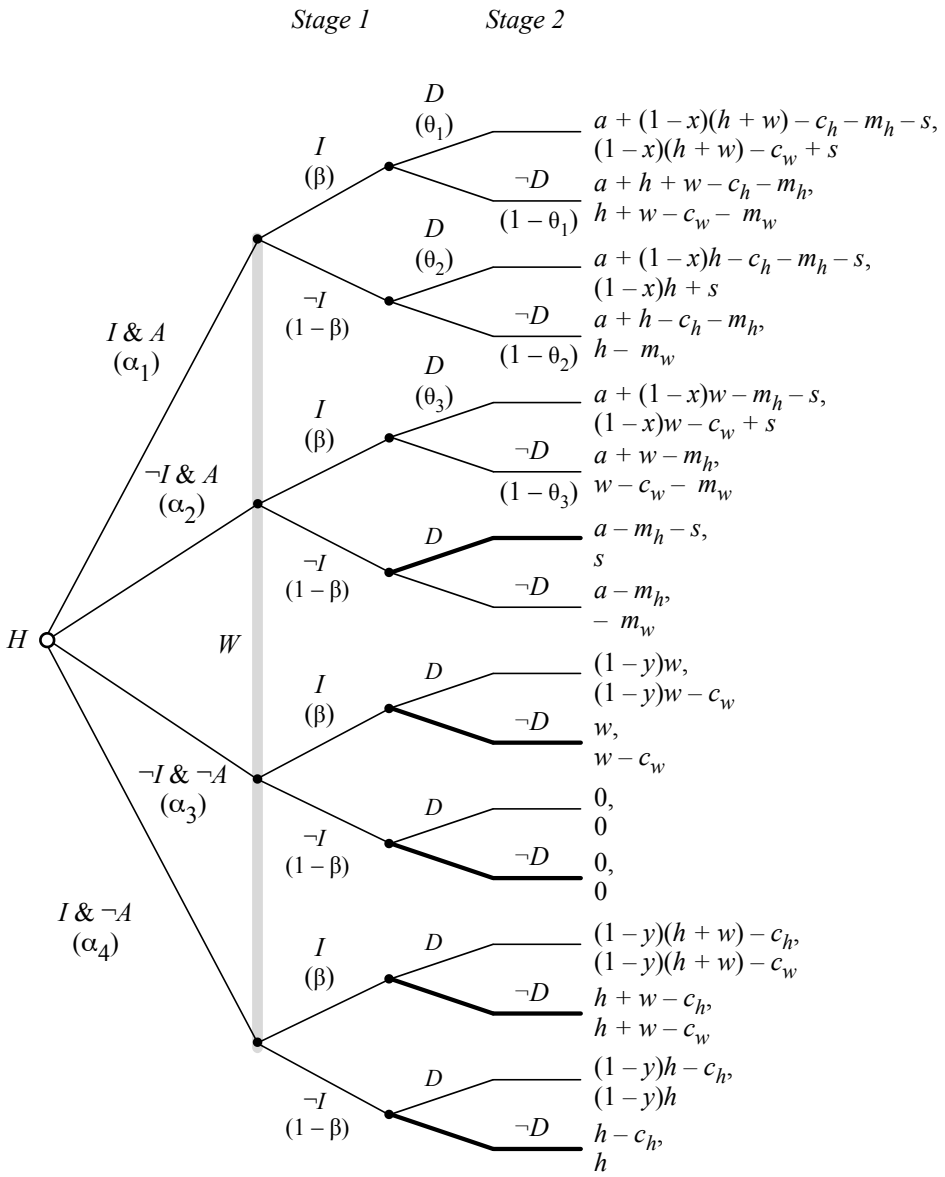


Figure 4.1: Game Tree for Extension I

3. If $c_h > \max\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h < \min\{-xh - xw + a - s, h - c_h - xh - xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1, \theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < \min\{h - xh - xw + a - m_h - s, h + xw - a + m_h + s\}$, $m_h < \min\{-xw + a - s, h - c_h - xh - xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1, \theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

In this first extension, as $m_w$ increases, the wife is more likely to divorce. As long as the investment return compensates for the cost, the wife chooses to invest. Other things equal, h has to be large enough to make the husband to invest. Both $m_h$ and $c_h$ depend on xw. This implies that the wife's decision regarding investment affects the husband's investment and adultery choices. The husband's own investment also affects his choice about adultery. For a large s, the husband is less likely to commit adultery because adultery is not worthwhile. Therefore, the couple's investment decision and legal sanctions influence the husband's choice about adultery. More specifically, if the wife's investment is significant, it reduces the likelihood of the husband's adultery.

**For** $\max\{xh, xw\} - s < m_w < xh + xw - s$**,** $c_w < w$

1. If $c_h > \max\{h + a - m_h, h + xw - a + m_h + s\}$, $m_h > \max\{a, -xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + a - m_h, h + xw - a + m_h + s\}$, $m_h > \max\{a, -xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h + a - m_h, h + xw - a + m_h + s\}$, $m_h < \min\{a, -xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1, \theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < \min\{h + a - m_h, h + xw - a + m_h + s\}$, $m_h < \min\{a, -xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

**For** $xw - s < m_w < xh - s$**,** $c_w < w$

1. If $c_h > \max\{h + a - m_h, h + xw - a + m_h + s\}$, $m_h > \max\{a, h - c_h + a, -xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + a - m_h, h + xw - a + m_h + s\}$, $m_h > \max\{a, h - c_h + a, -xw + a - s, -h + c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h+a-m_h, h+xw-a+m_h+s\}$, $m_h < \min\{a, h-c_h+a, -xw+a-s, -h+c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

4. If $c_h < \min\{h+a-m_h, h+xw-a+m_h+s\}$, $m_h < \min\{a, h-c_h+a, -xw+a-s, -h+c_h - xw + a - s\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

**For** $xh - s < m_w < xw - s$**,** $c_w < w$

1. If $c_h > \max\{h + a - m_h, h - a + m_h\}$, $m_h > \max\{a, -h + c_h + a\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + a - m_h, h - a + m_h\}$, $m_h > \max\{a, -h + c_h + a\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h + a - m_h, h - a + m_h\}$, $m_h < \min\{a, -h + c_h + a\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < \min\{h + a - m_h, h - a + m_h\}$, $m_h < \min\{a, -h + c_h + a\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $m_w < \min\{xh, xw\} - s$**,** $c_w < w$

1. If $c_h > \max\{h + a - m_h, h - a + m_h\}$, $m_h > \max\{a, -h + c_h + a, h - c_h + a\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + a - m_h, h - a + m_h\}$, $m_h > \max\{a, -h + c_h + a, h - c_h + a\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h + a - m_h, h - a + m_h\}$, $m_h < \min\{a, -h + c_h + a, h - c_h + a\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

4. If $c_h < \min\{h + a - m_h, h - a + m_h\}$, $m_h < \min\{a, -h + c_h + a, h - c_h + a\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

**For** $xw - s < m_w < xh - s$**,** $c_w > w$

1. If $c_h > h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

4. If $c_h < h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

**For** $m_w < \min\{xh, xw\} - s$**,** $c_w > w$

1. If $c_h > h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

4. If $c_h < h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

**For** $xh - s < m_w < xw - s$**,** $c_w < w - m_w - s$

1. If $c_h > h$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < h$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $m_w < \min\{xh, xw\} - s$**,** $c_w < w - m_w - s$

1. If $c_h > h$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < h$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

## 4.3 Summary of Extension I

In extension I, legal sanctions are only available when divorce occurs. In comparison to the base case, the wife is more likely to divorce in case of husband's adultery since the ranges of her morality can be lower to hold the conditions for the same equilibrium. Also, legal sanctions affect the wife's investment decisions in some cases, and yet in many cases, the wife makes the choice about investment based on her own investment outcome and costs, when she chooses to invest, her investment decisions influence both the husband's investment and adultery decisions. This implies that when her investment outcome is substantial, for a fixed amount of depreciation rate, the husband is more likely to invest and less likely to commit adultery.

Similar to the base case, although legal sanctions appear in the conditions for the husband's investment decisions whether it makes him more or less likely to invest depends on cases. When legal sanctions are not present, the husband makes his choice about whether to commit adultery or not based on the benefit of adultery and his own level of morality. For a given level of adultery benefits, if the husband's moral cost of committing adultery is high, adultery is not worthwhile. Therefore, we observe both legal sanctions and morality can reduce the likelihood of adultery.

In summary, when both legal sanctions and morality are not present, similar to what we have found from the base case, the non-adulterous spouse can invest to reduce the likelihood of adultery.

## 4.4 Extension II

In the second extension model, we make the modification based on the first extension model. In the previous two models, legal sanctions were independent (fixed). Now, we allow the legal sanctions to be proportional to investment which makes s a function of the husband and wife's investment outcomes (h, w). This implies that if the couple has accumulated a significant amount of investment outcomes throughout their time in the marriage, choosing to divorce as a result of adultery will lead to a greater cost for the husband and a greater benefit for the wife.

We replace the variable of the adultery-divorce specific depreciation rate x with $z_h$ and $z_w$ for the husband and wife respectively where $z_h = x + s$ and $z_w = x - s$. Since $z_h$ and $z_w$ are the new depreciation rates that we use to make s proportional to the investment outcomes, the ranges of $z_h$ and $z_w$ must remain between 0 and 1.

Since we have already shown the derivations in Appendix B, we use the very same derivations to find the equilibria for the second extension model. We simply replace x with $z_h$ and $z_w$ in the final step of derivations for the conditions to get conditions for the second extension. From the model, we observe that it becomes more costly for the husband to commit adultery when s is proportional to the investment outcomes, and thus reduces his likelihood of committing adultery. Also given his choice of adultery, he is less likely to invest. Furthermore, the wife's investment outcome can reduce the probability of adultery more than it used to in the first extension case.

## 4.5 Conditions and Equilibria for Extension II

**For** $m_w > xh + xw - s(h + w + 1)$**,** $c_w < w$

1. If $c_h > \max\{h - xh - xw + a - m_h - s(h + w + 1), h + xw - a + m_h + s(w + 1)\}$, $m_h > \max\{-xw + a - s(w+1), h - c_h - xh - xw + a - s(h+w+1), -h + c_h - xw + a - s(w+1)\}$:

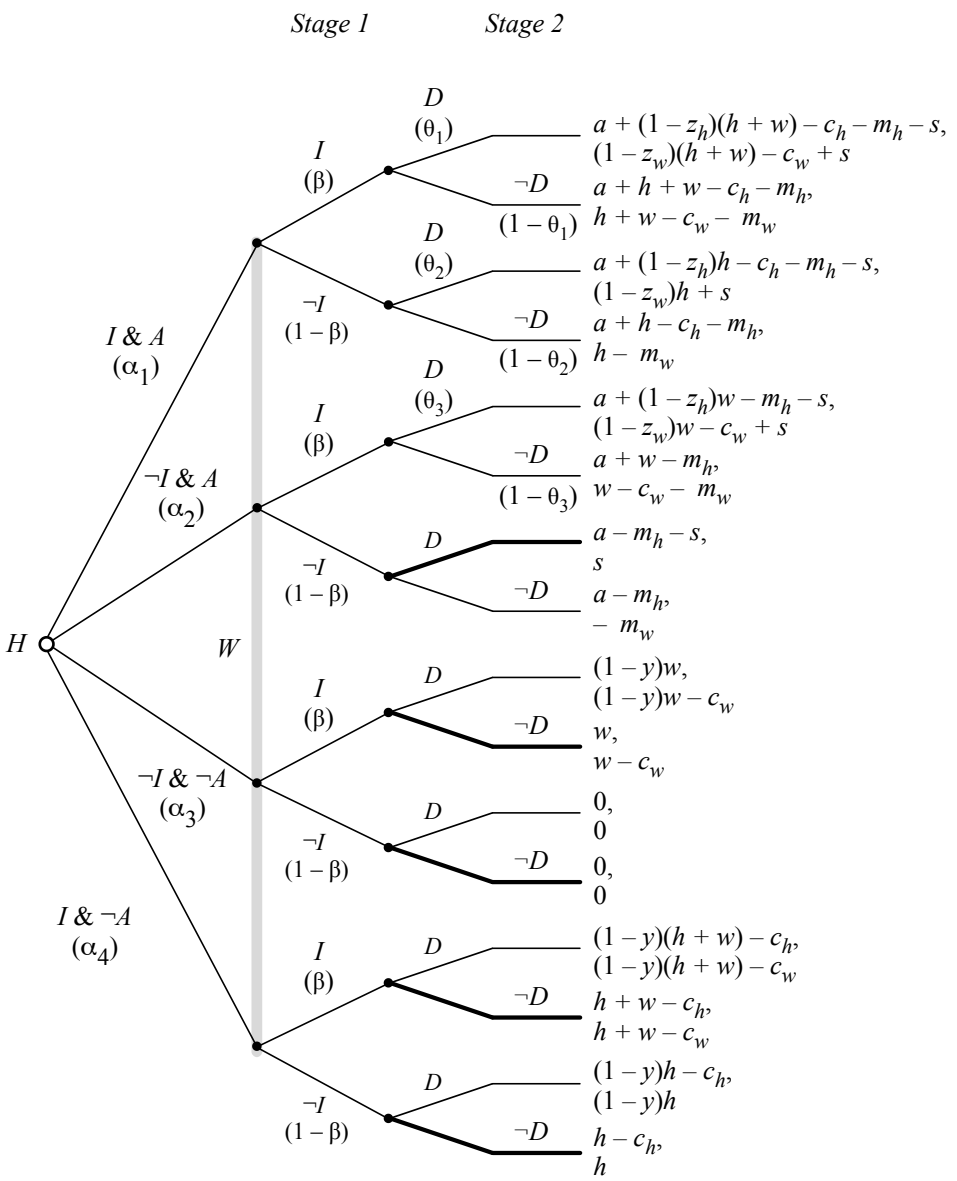


Figure 4.2: Game Tree for Extension II

in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h - xh - xw + a - m_h - s(h + w + 1), h + xw - a + m_h + s(w + 1)\}$, $m_h > \max\{-xw + a - s(w+1), h - c_h - xh - xw + a - s(h+w+1), -h + c_h - xw + a - s(w+1)\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h - xh - xw + a - m_h - s(h + w + 1), h + xw - a + m_h + s(w + 1)\}$, $m_h > \min\{-xh - xw + a - s(h+w+1), h - c_h - xh - xw + a - s(h+w+1), -h + c_h - xw + a - s(w+1)\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < \min\{h - xh - xw + a - m_h - s(h + w + 1), h + xw - a + m_h + s(w + 1)\}$, $m_h > \min\{-xh - xw + a - s(h+w+1), h - c_h - xh - xw + a - s(h+w+1), -h + c_h - xw + a - s(w+1)\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 1, \theta_2 = 1, \theta_3 = 1$.

In comparison to the first extension, now s is proportional to the investment. As h increases, $c_h$ becomes small to satisfy the conditions and thus it makes him less likely to invest. w still needs to be large enough to make $c_w$ small to satisfy the conditions. Since xw is in the conditions for the husband's decisions about investment and adultery, the wife can use her investment outcome to reduce the chance of the husband committing adultery when s is proportional. Also as described in the condition, when s is proportional to the investment, $m_h$ compared to the first extension becomes larger and reduces adultery.

**For** $\max\{xh, xw\} - s(\max\{h, w\} + 1) < m_w < xh + xw - s(h + w + 1)$**,** $c_w < w$

1. If $c_h > \max\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h > \max\{a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h > \max\{a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h < \min\{a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

4. If $c_h < \min\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h < \min\{a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 1$.

**For** $xw - s(w + 1) < m_w < xh - s(h + 1)$**,** $c_w < w$

1. If $c_h > \max\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h > \max\{a, h - c_h + a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < \min\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h > \max\{a, h - c_h + a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > \max\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h < \min\{a, h - c_h + a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

4. If $c_h < \min\{h + a - m_h, h + xw - a + m_h + s(w + 1)\}$, $m_h < \min\{a, h - c_h + a, -xw + a - s(w + 1), -h + c_h - xw + a - s(w + 1)\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

**For** $xh - s(h + 1) < m_w < xw - s(w + 1)$**,** $c_w < w$

1. If $c_h > \max\{h + a - m_h, h - a + m_h\}$, $m_h > max\{a, -h + c_h + a\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h$ <min$\{h+a-m_h, h-a+m_h\}$, $m_h > max\{a, -h+c_h+a\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h$ >max$\{h+a-m_h, h-a+m_h\}$, $m_h < min\{a, -h+c_h+a\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h$ <min$\{h+a-m_h, h-a+m_h\}$, $m_h < min\{a, -h+c_h+a\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $m_w < \min\{xh, xw\} - s(\min\{h, w\} + 1)$**,** $c_w < w$

1. If $c_h$ >max$\{h+a-m_h, h-a+m_h\}$, $m_h > max\{a, -h+c_h+a, h-c_h+a\}$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h$ <min$\{h+a-m_h, h-a+m_h\}$, $m_h > max\{a, -h+c_h+a, h-c_h+a\}$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h$ >max$\{h+a-m_h, h-a+m_h\}$, $m_h < min\{a, -h+c_h+a, h-c_h+a\}$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

4. If $c_h$ <min$\{h+a-m_h, h-a+m_h\}$, $m_h < min\{a, -h+c_h+a, h-c_h+a\}$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

**For** $xw - s(w+1) < m_w < xh - s(h+1)$**,** $c_w > w$

1. If $c_h > h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

4. If $c_h < h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 1$.

**For** $m_w < \min\{xh, xw\} - s(\min\{h, w\} + 1)$**,** $c_w > w$

1. If $c_h > h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h + s$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 0$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < h + s$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 0$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

**For** $xh - s(h + 1) < m_w < xw - s(w + 1)$**,** $c_w < w - m_w - s$

1. If $c_h > h$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

4. If $c_h < h$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 1, \theta_3 = 0$.

**For** $m_w < \min\{xh, xw\} - s(\min\{h, w\} + 1)$**,** $c_w < w - m_w - s$

1. If $c_h > h$, $m_h > a$: in this case, the equilibrium is $\alpha_3 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

2. If $c_h < h$, $m_h > a$: in this case, the equilibrium is $\alpha_4 = 1, \beta = 1$, and the value of $\theta$s is either 0 or 1.

3. If $c_h > h$, $m_h < a$: in this case, the equilibrium is $\alpha_2 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

4. If $c_h < h$, $m_h < a$: in this case, the equilibrium is $\alpha_1 = 1, \beta = 1$, $\theta_1 = 0, \theta_2 = 0, \theta_3 = 0$.

## 4.6 Summary of Extension II

The structure of the game remains the same as extension I, but now the legal sanctions are proportional to the investment outcomes. In comparison to extension I, the wife is more likely to divorce due to her moral cost being in a lower range. Still, in most cases, the wife's investment decisions are made based on her own investment costs and benefits. In a couple exceptional cases however, both the wife's moral cost of living with an adulterous husband and legal sanctions play roles in her decisions about the investment. In those cases, if legal sanctions are large, other things remain the same, the wife is less likely to invest.

Similar to both base case and extension I, both the husband's moral cost of committing adultery and legal sanctions against adultery work in the same direction to reduce the likelihood of adultery. In most cases, when legal sanctions are present, he is more likely to invest and less likely to commit adultery because the variable for legal sanctions is added in the benefit for investment and subtracted from the benefit from committing adultery in the conditions given in 4.4. In addition, If the wife chooses to invest, her investment choice makes the husband more likely to invest and less likely to commit adultery. Therefore, similar to

extension I, when both legal sanctions and morality against adultery are not present, the non-adulterous spouse can invest in the marriage to lower the probability of adultery.

# Chapter 5

# Results and Discussion

## 5.1 Synthesis

Across different cases, we observe that both legal sanctions and morality regarding adultery reduce its likelihood. When legal sanctions are present, given the husband's morality level, he is less likely to commit adultery because it is not worthwhile. Also, other things remaining equal, an increase in the husband's morality standards will make the cost of committing adultery high, thus reducing the likelihood of adultery. When both factors are present, they work towards the same end.

From extension cases, when legal sanctions are present, both the husband and wife's investment decisions influence the husband's choice about adultery. In fact, when they choose to invest, their investment decisions lower his adultery likelihood. This is because when large legal sanctions are present while everything else remains the same, the wife knows that the husband is less likely to commit adultery due to a relative decrease in the benefit he gains from adultery. Then the wife invests more in the marriage and the husband, knowing the wife is less likely to divorce when she invests significantly, will also invest in the marriage. Since he now has much to lose when he commits adultery and faces divorce, he is less likely to commit adultery.

Also, their investment decisions influence the likelihood of adultery occurring because when the legal punishment is so severe, the husband is less enticed to commit adultery and is more convinced to invest in the marriage instead. In turn, the wife would also invest in the marriage because she sees that her husband is choosing to invest in the marriage.

Therefore, the husband is less likely to commit adultery when both of them choose to invest in the marriage. However, as it has been shown in the extension cases, when legal sanctions only appear when divorce occurs and if the wife chooses not to invest, the husband makes investment and adultery choices based on his own investment costs and benefits, and the benefits of adultery.

As was explained in extension II, in cases where legal sanctions are proportional to investment outcomes, the wife is more likely to divorce. This is because the range of her moral cost can be lowered yet still satisfy the same equilibrium conditions. Also, when legal sanctions are proportional to investment, as the size of accumulated investment increases, legal punishment also increases and thus leads the husband to be less likely to commit adultery.

In summary, when legal sanctions and morality against adultery are present, they reduce the likelihood of adultery. If none of them are present, then investment can lower the probability of adultery.

## 5.2 Implications

As mentioned earlier, adultery laws vary across different states and countries. We look at the impact of legal sanctions in different countries to examine the implications of our models.

### 5.2.1 Turkey

Turkey has debated the criminalization of adultery for decades. Until 1996 when Turkish courts denied adultery laws for inequality reasons,[13] adulterers who were found guilty received up to three years of imprisonment.

In 2004, the Turkish government leaders proposed to re-criminalize adultery. Soon after however, the government was criticized by the European Union(EU) officials and a number

[13]Collins, Catherine. "Turkey Debates Reviving Criminal Law on Adultery." Chicago Tribune, 14 Sept. 2004. Web. 25 Feb. 2014.

of women's rights groups who protested against re-criminalizing adultery.[14] The Turkish government's attempt to re-criminalize adultery failed because a requirement for joining the EU was to adopt the EU policies, which meant no revival of adultery laws. One of the major reasons why the EU officials were opposed to the idea of criminalizing adultery was that they viewed adultery laws as an example of Islamic laws entering Turkish laws.[15]

The following is an example of how public punishment of adultery aligns with the private punishment. As reported in the Guardian, Guldunya Tore, a 22-year-old woman was killed in Istanbul in February. She had fled her home after she became impregnated by her cousin's husband after having consensual sex. Soon after she gave birth to her child, she was shot in the streets, but fortunately survived. While her stay at the hospital she asked for police protection, was refused. Later, she was found dead.[16]

Turkey is predominantly Muslim and its religious rules are very strict, which is why the EU officials consider adultery laws as Islamic laws entering Turkish laws. The moral cost of committing adultery is very high already, yet criminalizing adultery would add to the severity of the punishment. Also, because human rights advocates fear that criminalizing adultery would encourage "honor killings,"[17] which would endow men with more power and authority, and increase the likelihood of crimes against women,[18] adultery laws were prohibited from re-entering these statute.

Our model explains this through the alignment of morality and legal sanctions. Although legal sanctions and moral rules against adultery reduce the likelihood of adultery, when both are available and severe, they may result in unexpected outcomes such as "honor killings." The rules exist to establish an order of society, not to encourage other people to violate civil

[14]ANKARA. "Turkey Backs off Plan to Outlaw Adultery." USA TODAY, 14 Sept. 2004. Web. 10 Mar. 2014.

[15]AFP/DW. "Verheugen Warns Turkey on Adultery Law." DW, 9 Oct. 2004. Web. 20 Mar. 2014.

[16]Dymond, Jonny. "Outcry as Turks Plan Law to Ban Adultery." The Observer. Guardian News and Media, 11 Sept. 2004. Web. 22 Mar. 2014.

[17]Zaman, Amberin. "Turkey Scraps Adultery Law Plan." Los Angeles Times, 15 Sept. 2004. Web. 22 Mar. 2014.

[18]Sachs, Susan. "Adultery a Crime? The Turks Think Again and Say No." The New York Times, 15 Sept. 2004. Web. 22 Mar. 2014.

laws and punish the adulterers on their own.

### 5.2.2 Pennsylvania

Pennsylvania (1972)[19] and Colorado (2013)[20] repealed adultery laws. Since Colorado has only very recently abolished adultery laws, we will examine the impact of de-criminalization of adultery in Pennsylvania.

The court case, *Hollenbaugh v. Carnegie Free Library* was brought up when the plaintiffs, Hollenbaugh and Philburn, committed adultery and had an illegitimate child. They were discharged and the conclusion of the case has extended the constitutionally-guaranteed right of privacy under the First, Fourth, Ninth, and Fourteenth Amendments of the Constitution to several areas that have been traditionally considered "immoral."[21] The court decisions including *Eisenstadt v. Baird, 405 U.S. 438, 92 S.Ct. 1029, 31 L.Ed.2d 349 (1972)* state clearly that "only personal rights that can be deemed 'fundamental' or 'implicit in the concept of ordered liberty' are included in this guarantee of personal privacy."[22] Although a review of the above cases does not imply the right of privacy of those that were considered immoral as "fundamental" privacy rights, they do demonstrate that the rights protect the personal intimacies of the home, the family, and motherhood.

As discussed earlier, having legal sanctions against adultery may crowd out a society's sense of morality. Although liberal societies may not have strict moral rules, individuals determine their own level of morality and behave accordingly. Having legal sanctions against immoral behaviors may prohibit individuals from setting their own moral levels. Not only do adultery laws crowd out the morality problem, they are also very costly for the government to enforce. This why the state of Pennsylvania achieves protection of the personal intimacies of the home through the de-criminalization of adultery. Therefore, having legal sanctions against adultery may not be desirable in such societies.

[19]1972 Pa. Laws, Act No. 334, 5
[20]HB 13-1166 repeal 18-6-501
[21]Hollenbaugh v. Carnegie Free Library. District Court, W.D. Pennsylvania. 1977. N.p., n.d. Web.
[22]Roe v. Wade, supra 410 U.S. at 152, 93 S.Ct. at 726.

# Chapter 6

# Conclusion

Since we considered only discrete cases for analysis in this paper and looked at different conditions for each equilibrium, we may not have a comprehensive picture of the model as we would have had if we had a continuous case with one equilibrium. In future studies, we hope to use probability spaces for each player's decisions.

Future research can be done to see if our findings apply in a real world setting using the data. The model can be extended to describe the impact of punishment on the third-person on the probability of adultery. The following two cases serve as our motivations for continuing this research. According to Yahoo News Singapore, a Taiwanese widow received a 298-year sentence for having an affair with a neighbor.[23] Over a course of five years, they had a total of 894 trysts, and according to Taiwanese law, each offense counted for a four-month period of imprisonment. The adulterer's wife filed the complaint against both the widow and her husband, but eventually decided to forgive him and drop the lawsuit against him. She did not however, drop the charges against the mistress. Additionally, in 2010, a woman from North Carolina received a total of $9 million in damages as compensation for her husband's adultery.[24] The jury reached the verdict to give her a $5 million compensation for her husband's adultery and a $4 million penalty from the mistress. This happened because North Carolina laws allow spouses to sue third parties for damaging the marriage.[25] Drawing on these cases, we want to see whether punishing an illicit lover can reduce the probability

[23]AFP. "'298-year Sentence' Sparks Taiwan Adultery Law Debate." Yahoo News Singapore. AFP, 2 Sept. 2013. Web. 25 Mar. 2014.

[24]Allen, Nick. "Wife's $9m Victory in Adultery Case Warns Mistresses to 'lay Off'" The Telegraph. Telegraph Media Group, 21 June 0053. Web. 26 Feb. 2014.

[25]Gomstyn, Alice. "Wife Wins $9 Million From Husband's Alleged Mistress." ABC News. ABC News Network, 22 Mar. 2010. Web. 25 Feb. 2014.

of adultery. Since our current model does not have a mechanism to explain the effect of punishing an illicit lover on reducing the likelihood of adultery, we would like to develop a model that explains such a circumstance to see if punishing third parties can reduce the likelihood of adultery.

This paper demonstrates that in equilibrium, adultery occurs only when there are enough benefits to compensate for all possible costs, including one's moral cost of committing adultery and the public punishment for violating laws if adultery is illegal. If legal sanctions are only available when divorce occurs, both the husband and wife's investment decisions influence the adultery choice. If the couple has accumulated a substantial amount of marriage specific investment over time and the husband knows the wife will divorce in any case if adultery occurs, then he is less likely to commit adultery due to a fear of a large loss of the investment. Also, if the husband knows the wife will not divorce in any case, he makes the choice about adultery without taking legal sanctions into account. When legal sanctions are proportional to investment outcomes, the ranges of the wife's morality can be in lower range than when they are fixed. Also, having a high level of morality or legal sanctions against adultery, or both, can reduce the likelihood of adultery. If these factors are not present, investing in the marriage-specific investment can reduce the likelihood of adultery.

We also verified Rasmusen's claim that adulterous behavior can be deterred through legal sanctions and morality. While Rasmusen focuses more on different types and features of legal punishment of adultery and uses verbal models for explanation, we analyze through a game theoretic model. More importantly, we introduce morality in the model to see the impact of adultery laws when moral rules against adultery are present. Despite the government's responsibility to enforce legal sanctions against adultery, legal sanctions may not be necessary in countries that have strict moral rules, or at the very least, they may not need to be enforced. Since legal sanctions and adultery reinforce one another, having overly severe legal sanctions or moral rules may cause undesirable outcomes, as seen in the example of the Turkish woman. Therefore, it is important for any government to carefully

consider and measure the level of morality in its own society and determine whether or not it needs legal sanctions. Additionally, as individuals cannot control legal sanctions and the level of morality of others, when legal sanctions and/or morality are not available, both the husband and wife can increase the investment outcome to reduce the likelihood of adultery of the other spouse.

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# Chapter 7

# Appendices

## 7.1 Appendix A

### 7.1.1 Derivations of the Conditions for Basic Model

**Wife's Divorce Decision**

1. Given IA and I,

   $\mathrm{E(D)} = (1-x)(h+w) - c_w + s$

   $\mathrm{E}(\neg\mathrm{D}) = h + w - c_w - m_w + s$

   The wife chooses to divorce, $\theta_1 = 1$, if and only if $m_w > xh + xw$

2. Given IA and ¬I,

   $\mathrm{E(D)} = (1-x)h + s$

   $\mathrm{E}(\neg\mathrm{D}) = h - m_w + s$

   The wife chooses to divorce, $\theta_2 = 1$, if and only if $m_w > xh$

3. Given ¬IA and I,

   $\mathrm{E(D)} = (1-x)w - c_w + s$

   $\mathrm{E}(\neg\mathrm{D}) = w - c_w - m_w + s$

   The wife chooses to divorce, $\theta_3 = 1$, if and only if $m_w > xw$

We now consider two sub-cases: 1. if $h \geq w$ and 2. $h < w$.

Case 1. $h \geq w$

i. For type I women, $m_w > xh + xw$. $\therefore (\theta_1, \theta_2, \theta_3) = (1, 1, 1)$.

ii. For type II women, $xh < m_w < xh + xw$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 1, 1)$.

iii-(1). For type III women, $xw < m_w < xh$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 0, 1)$.

iv. For type IVwomen, $mw < xw$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 0, 0)$.

Case 2. $h < w$

i. For type I women, $m_w > xh + xw$. $\therefore (\theta_1, \theta_2, \theta_3) = (1, 1, 1)$.

ii. For type II women, $xw < m_w < xh + xw$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 1, 1)$.

iii-(2). For type III women, $xh < m_w < xw$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 1, 0)$.

iv. For type IVwomen, $mw < xh$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 0, 0)$.

Since the sub-cases i, ii, and iv have the identical values of the $\theta$s in both case 1 and 2, we only need to consider iii-2 from case 2 in addition to the sub-cases of case 1.

**Wife's Investment Decision**

The wife's expected payoffs are the following:

$\mathrm{E(I)} = \alpha_1[\theta_1((1-x)(h+w)+s) + (1-\theta_1)(h+w-m_w+s)] + \alpha_2[\theta_3((1-x)w+s) + (1-\theta_3)(w-m_w+s)] + \alpha_3(w) + \alpha_4(h+w) - c_w$

$\mathrm{E(\neg I)} = \alpha_1[\theta_2(1-x)h+s) + (1-\theta_2)(h-m_w+s)] + \alpha_2(s) + \alpha_3(0) + \alpha_4(h)$

$\therefore$ She will choose to invest if and only if $\alpha_1[h(\theta_2-\theta_1)x + w(1-\theta_1 x)] + \alpha_2[w(1-\theta_3 x)] + \alpha_3 w + \alpha_4 w - m_w[\alpha_1(\theta_2-\theta_1) + \alpha_2(1-\theta)] > c_w$

**Husband's Investment and Adultery Decision**

The husband's expected payoffs are the following:

$\mathrm{E(IA)} = \beta[\theta_1(a + (1-x)(h+w) - c_h - m_h - s) + (1-\theta_1)(a + h + w + c_h - m_h - s)] + (1 - \beta)[\theta_2(a + (1-x)h - c_h - m_h - s) + (1-\theta_2)(a + h - c_h - m_h - s)]$

$\mathrm{E(\neg IA)} = \beta[\theta_3(a + (1-x)w - m_h - s) + (1-\theta_3)(a + w - m_h - s)] + (1-\beta)[a - m_h - s]$

$\mathrm{E(\neg I \neg A)} = \beta \mathrm{w}$

$\mathrm{E(I \neg A)} = \beta w + h - c_h$

For the husband's decision, we consider two sub-cases: 1. if $h > c_h$ and 2. $h < c_h$.

Case 1. $h > c_h$ ($\alpha_3 = 0$ and $\alpha_4 > 0$)

i. $\alpha_1 = 1$ if and only if $E(IA) > E(\neg IA)$ and $E(IA) > E(I\neg A)$.

$\therefore$ If $\beta[xw(\theta_3 - \theta_1) + h(1 - \theta_1 x)] + (1-\beta)[h(1-\theta_2 x)] - c_h > 0$ and $-xh(\beta\theta_1 + (1-\beta)\theta_2) - \beta x \theta_1 w + a - m_h - s > 0$, he chooses to invest and to commit adultery.

ii. $\alpha_2 = 1$ if and only if $E(\neg IA) > E(IA)$ and $E(\neg IA) > E(I\neg A)$.

$\therefore$ If $\beta[xw(\theta_3 - \theta_1) + h(1 - \theta_1 x)] + (1-\beta)[h(1-\theta_2 x)] - c_h < 0$ and $-\beta x \theta_3 w - h + c_h + a - m_h - s > 0$, he chooses not to invest and to commit adultery.

iii. $\alpha_4 = 1$ if and only if $E(I\neg A) > E(IA)$ and $E(I\neg A) > E(\neg IA)$.

$\therefore$ If $-xh(\beta\theta_1 + (1-\beta)\theta_2) - \beta x \theta_1 w + a - m_h - s < 0$ and $-\beta x \theta_3 w - h + c_h + a - m_h - s < 0$, he chooses to invest and to not commit adultery.

Case 2. $h < c_h$ ($\alpha_3 > 0$ and $\alpha_4 = 0$)

i. $\alpha_1 = 1$ if and only if $E(IA) > E(\neg IA)$ and $E(IA) > E(\neg I \neg A)$.

$\therefore$ If $\beta[xw(\theta_3 - \theta_1) + h(1 - \theta_1 x)] + (1-\beta)[h(1-\theta_2 x)] - c_h > 0$ and $h - c_h - xh(\beta\theta_1 + (1-\beta)\theta_2) - \beta\theta_1 x w + a - m_h - s > 0$, he chooses to invest and to commit adultery.

ii. $\alpha_2 = 1$ if and only if $E(\neg IA) > E(IA)$ and $E(\neg IA) > E(\neg I \neg A))$.

$\therefore$ If $\beta[xw(\theta_3 - \theta_1) + h(1 - \theta_1 x)] + (1 - \beta)[h(1 - \theta_2 x)] - c_h < 0$ and $-\beta x \theta_3 w + a - m_h - s > 0$, he chooses not to invest and to commit adultery.

iii. $\alpha_3 = 1$ if and only if E($\neg$I$\neg$ A)¿E(IA) and E($\neg I \neg A) > E(\neg IA)$

$\therefore$ If $h - c_h - xh(\beta\theta_1 + (1 - \beta)\theta_2) - \beta x \theta_1 w + a - m_h - s < 0$ and $-\beta x \theta_3 w + a - m_h - s < 0$, he chooses to not invest and to not commit adultery.

## 7.2 Appendix B

### 7.2.1 Derivations of the Conditions for Extensions

**Wife's Divorce Decision**

1. Given IA and I,

   $\mathrm{E(D)} = (1-x)(h+w) - c_w$

   $\mathrm{E}(\neg\mathrm{D}) = h + w - c_w - m_w + s$

   The wife chooses to divorce, $\theta_1 = 1$, if and only if $m_w > xh + xw - s$

2. Given IA and ¬I,

   $\mathrm{E(D)} = (1-x)h + s$

   $\mathrm{E}(\neg\mathrm{D}) = h - m_w$

   The wife chooses to divorce, $\theta_2 = 1$, if and only if $m_w > xh - s$

3. Given ¬IA and I,

   $\mathrm{E(D)} = (1-x)w - c_w + s$

   $\mathrm{E}(\neg\mathrm{D}) = w - c_w - m_w$

   The wife chooses to divorce, $\theta_3 = 1$, if and only if $m_w > xw - s$

We now consider two sub-cases: 1. if $h \geq w$ and 2. $h < w$.

Case 1. $h \geq w$

i. For type I women, $m_w > xh + xw - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (1, 1, 1)$.

ii. For type II women, $xh - s < m_w < xh + xw - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 1, 1)$.

iii-(1). For type III women, $xw - s < m_w < xh - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 0, 1)$.

iv. For type IVwomen, $mw < xw - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 0, 0)$.

Case 2. $h < w$

i. For type I women, $m_w > xh + xw - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (1, 1, 1)$.

ii. For type II women, $xw - s < m_w < xh + xw - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 1, 1)$.

iii-(2). For type III women, $xh - s < m_w < xw - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 1, 0)$.

iv. For type IV women, $mw < xh - s$. $\therefore (\theta_1, \theta_2, \theta_3) = (0, 0, 0)$.

Same as the base case, for sub-cases i, ii, and iv we have the identical values of the $\theta$s in both case 1 and 2. Thus we only consider iii-2 from case 2 in addition to all the sub-cases from case 1.

**Wife's Investment Decision**

The wife's expected payoffs are the following:

$\mathrm{E(I)} = \alpha_1[\theta_1((1-x)(h+w)+s) + (1-\theta_1)(h+w-m_w)] + \alpha_2[\theta_3((1-x)w+s) + (1-\theta_3)(w - m_w)] + \alpha_3(w) + \alpha_4(h+w) - c_w$

$\mathrm{E(\neg I)} = \alpha_1[\theta_2(1-x)h + s) + (1-\theta_2)(h - m_w)] + \alpha_2(s) + \alpha_3(0) + \alpha_4(h)$

$\therefore$ She will choose to invest if and only if $\alpha_1[h(\theta_2 - \theta_1)x + w(1 - \theta_1 x)] + \alpha_2[w(1 - \theta_3 x)] + \alpha_3 w + \alpha_4 w - m_w[\alpha_1(\theta_2 - \theta_1) + \alpha_2(1 - \theta)] - s[\alpha_1(\theta_2 - \theta_1) + \alpha_2(1 - \theta_3)] > c_w$

**Husband's Investment and Adultery Decision**

The husband's expected payoffs are the following:

$\mathrm{E(IA)} = \beta[\theta_1(a + (1-x)(h+w) - c_h - m_h - s) + (1-\theta_1)(a + h + w + c_h - m_h)] + (1 - \beta)[\theta_2(a + (1-x)h - c_h - m_h - s) + (1-\theta_2)(a + h - c_h - m_h)]$

$\mathrm{E(\neg IA)} = \beta[\theta_3(a + (1-x)w - m_h - s) + (1-\theta_3)(a + w - m_h)] + (1-\beta)[a - m_h - s]$

$\mathrm{E(\neg I \neg A)} = \beta \mathrm{w}$

$\mathrm{E}(\mathrm{I}\neg\mathrm{A}) = \beta w + h - c_h$

For the husband's decision, we consider two sub-cases: 1. if $h > c_h$ and 2. $h < c_h$.

Case 1. $h > c_h$ ($\alpha_3 = 0$ and $\alpha_4 > 0$)

i. $\alpha_1 = 1$ if and only if $E(IA) > E(\neg IA)$ and $E(IA) > E(I\neg A)$.

$\therefore$ If $\beta[xw(\theta_3-\theta_1)+h(1-\theta_1 x)]+(1-\beta)[h(1-\theta_2 x)]+s[\beta(\theta_3-\theta_1)+(1-\beta)(1-\theta_2)]-c_h > 0$ and $-xh(\beta\theta_1 + (1-\beta)\theta_2) - \beta x\theta_1 w + a - m_h - s[\beta\theta_1 + (1-\beta)\theta_2] > 0$, he chooses to invest and to commit adultery.

ii. $\alpha_2 = 1$ if and only if $E(\neg IA) > E(IA)$ and $E(\neg IA) > E(I\neg A)$.

$\therefore$ If $\beta[xw(\theta_3-\theta_1)+h(1-\theta_1 x)]+(1-\beta)[h(1-\theta_2 x)]+s[\beta(\theta_3-\theta_1)+(1-\beta)(1-\theta_2)-c_h < 0$ and $-\beta x\theta_3 w - h + c_h + a - m_h - s[\beta\theta_3 + (1-\beta)] > 0$, he chooses not to invest and to commit adultery.

iii. $\alpha_4 = 1$ if and only if $E(I\neg A) > E(IA)$ and $E(I\neg A) > E(\neg IA)$.

$\therefore$ If $-xh(\beta\theta_1 + (1-\beta)\theta_2) - \beta x\theta_1 w + a - m_h - s[\beta\theta_1 + (1-\beta)\theta_2) < 0$ and $-\beta x\theta_3 w - h + c_h + a - m_h - s < 0$, he chooses to invest and not to commit adultery.

Case 2. $h < c_h$ ($\alpha_3 > 0$ and $\alpha_4 = 0$)

i. $\alpha_1 = 1$ if and only if $E(IA) > E(\neg IA)$ and $E(IA) > E(\neg I\neg A)$.

$\therefore$ If $\beta[xw(\theta_3-\theta_1)+h(1-\theta_1 x)]+(1-\beta)[h(1-\theta_2 x)]-s[\beta(\theta_3-\theta_1)+(1-\beta)(1-\theta_2]-c_h > 0$ and $h - c_h - xh(\beta\theta_1 + (1-\beta)\theta_2) - \beta\theta_1 xw + a - m_h - s[\beta\theta_1 + (1-\beta)\theta_2] > 0$, he chooses to invest and to commit adultery.

ii. $\alpha_2 = 1$ if and only if $E(\neg IA) > E(IA)$ and $E(\neg IA) > E(\neg I\neg A)$).

$\therefore$ If $\beta[xw(\theta_3-\theta_1)+h(1-\theta_1 x)]+(1-\beta)[h(1-\theta_2 x)]-s[\beta(\theta_3-\theta_1)+(1-\beta)(1-\theta_2]-c_h < 0$ and $-\beta x\theta_3 w + a - m_h - s[\beta\theta_3 + (1-\beta)] > 0$, he chooses not to invest and to commit adultery.

iii. $\alpha_3 = 1$ if and only if $\mathrm{E}(\neg I \neg A) > E(IA)$ and $\mathrm{E}(\neg I \neg A) > E(\neg IA)$

$\therefore$ If $h - c_h - xh(\beta\theta_1 + (1-\beta)\theta_2) - \beta\theta_1 xw + a - m_h - s[\beta\theta_1 + (1-\beta)\theta_2] < 0$ and $-\beta x\theta_3 w + a - m_h - s[\beta\theta_3 + (1-\beta)] < 0$, he chooses not to invest and not commit adultery.

## 7.3 Appendix C

### 7.3.1 Equilibria and Conditions for Base Model

1. ((IA), ¬I,D))

**Equilibrium**: $\alpha_1 = 1, \beta = 0, \theta_2 = 0$ (the value of other $\theta$s can be either 0 or 1)

**Conditions**:

i. $c_w > w$, $m_w < xh$, $c_h < h$, $a > m_h + s$

2. ((¬IA), (I,D))

**Equilibrium**: $\alpha_2 = 1, \beta = 1, \theta_3 = 1$

**Conditions**:

i. $c_w < w(1-x)$, $m_w > xw$, $c_h > h - xh$, and $a > xw + m_h + s$

3. ((¬IA), ¬I,D))

**Equilibrium**: $\alpha_2 = 1, \beta = 0$ (the value of $\theta$s is either 0 or 1)

**Conditions**:

i. $c_w > w - xw$, $c_h > h - xh$, and $a > m_h + s$

4. $((\neg I \neg A), (\neg I, \neg$D))

**Equilibrium**: $\alpha_3 = 1, \beta = 0$ (the value of $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh+xw$, $c_w > w$, $c_h > h-xh+a-m_h-s$, $m_h > a-s$, and $m_h > h-c_h-xh+a-s$

ii. $\max\{xh, xw\} <$ $m_w <$xh+xw, $c_h > h - xh + a - m_h - s$, and $m_h > h - c_h - xh + a - s$

iii. $xw < m_w < xh$, $c_h > h - xh + a - m_h - s$, $m_h > a - s$, and $m_h > h - c_h + a - s$

iv. $xh < m_w < xw$, $c_h > h - xh + a - m_h - s$, $m_h > a - s$, and $m_h > h - c_h - xh + a - s$

v. $m_w < min\{xh, xw\}$, $c_h > h - xh + a - m_h - s$, $m_h > a - s$, and $m_h > h - c_h + a - s$

5. $((\text{I } \neg A), (\neg I, \neg \text{D}))$

**Equilibrium**: $\alpha_4 = 1, \beta = 0$ (the value of $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh+xw$, $c_w > w$, $c_h > h-a+m_h+s$, $m_h > -xh+a-s$, and $m_h > -h+c_h+a-s$

ii. $\max\{xh, xw\} < m_w < xh + xw$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -xh + a - s$, and $m_h > -h + c_h + a - s$

iii. $xw < m_w < xh$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > a - s$, and $m_h > -h + c_h + a - s$

iv. $xh < m_w < xw$, $c_w > w$, $c_h > h-a+m_h+s$, $m_h > -xh+a-s$, and $m_h > -h+c_h+a-s$

v. $m_w < min\{xh, xw\}$, $c_w > w$, $c_h > h-a+m_h+s$, $m_h > a-s$, and $m_h > -h+c_h+a-s$

## 7.4 Appendix D

### 7.4.1 Equilibria and Conditions for Extensions

**Extension Model I**

1. ((IA),(I,¬D))

**Equilibrium**: $\alpha_1 = 1, \beta = 1, \theta_1 = 0$ (the value of other $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w < xh + w - m_w - s$, $c_h < h + xw + s$, and $m_h < a$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w < xh + w - m_w - s$, $c_h < h + xw + s$, and $m_h < a$

iii. $xw - s < m_w < xh - s$, $c_w < w$, $c_h < h$, and $m_h < a$

iv. $xh - s < m_w < xw - s$, $c_w < xh + w - m_w - s$, $c_h < h + xw + s$, and $m_h < a$

v. $m_w < min\{xh, xw\} - s$, $c_w < w$, $c_h < h$, and $m_h < a$

2. ((IA),(¬I,D))

**Equilibrium**: $\alpha_1 = 1, \beta = 0, \theta_2 = 0$ (the value of other $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w > w - xw$, $c_h < h - xh$, and $m_h < -xh + a - s$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w > xh - w - m_w - s$, $c_h < h - xh$, and $m_h < -xh + a - s$

iii. $xh - s < m_w < xw - s$, $c_w > xh - w - m_w - s$, $c_h < h - xh$, and $m_h < -xh + a - s$

3. ((¬IA),(I,D))

**Equilibrium**: $\alpha_2 = 1, \beta = 1, \theta_3 = 1$ (the value of other $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w < w - xw$, $c_h > h - xh$, and $m_h < -xw + a - s$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w < w - xw$, $c_h > h + xw + s$, and $m_h < -xw + a - s$

iii. $xw - s < m_w < xh - s$, $c_w < w - xw$, $c_h > h + xw + s$, and $m_h < -xw + a - s$

4. ((¬IA),(¬I,D))

**Equilibrium**: $\alpha_2 = 1, \beta = 0$ (the value of other $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w > w - xw$, $c_h > h - xh$, and $m_h < a - s$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w > w - xw$, $c_h > h - xh$, and $m_h < a - s$

iii. $xw - s < m_w < xh - s$, $c_w > w - xw$, $c_h > h - xh$, and $m_h < a - s$

iv. $xh - s < m_w < xw - s$, $c_w > w - m_w - s$, $c_h > h - xh$, and $m_h < a - s$

v. $m_w < min\{xh, xw\} - s$, $c_w > w - m_w - s$, $c_h > h - xh$, and $m_h < a - s$

5. ((¬$I$¬ A),(¬I,¬D))

**Equilibrium**: $\alpha_3 = 1, \beta = 0$ (the value of $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w > w$, $c_h > h - xh + a - m_h - s$, $m_h > a - s$, and $m_h > h - c_h - xh + a - s$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w > w$, $c_h > h - xh + a - m_h - s$, $m_h > a - s$, and $m_h > h - c_h - xh + a - s$

iii. $xw - s < m_w < xh - s$, $c_h > h + a - m_h$, $m_h > a - s$, and $m_h > h - c_h + a$

iv. $xh - s < m_w < xw - s$, $c_h > h - xh + a - m_h - s$, $m_h > a - s$, and $m_h > h - c_h - xh + a - s$

v. $m_w < min\{xh, xw\} - s$, $c_h > h + a - m_h$, $m_h > a - s$, and $m_h > h - c_h + a$

6. ((*I*¬A),(¬I,¬D))

**Equilibrium**: $\alpha_4 = 1, \beta = 0$ (the value of $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > -xh + a - s$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > -xh + a - s$

iii. $xw - s < m_w < xh - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > a$

vi. $xh - s < m_w < xw - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > -xh + a - s$

v. $m_w < min\{xh, xw\} - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > a$

**Extension Model II**

1. ((IA),(¬*I*, ¬D))

**Equilibrium**: $\alpha_1 = 1, \beta = 0, \theta_2 = 0$ (the value of other $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w > w - xw + sw$, $c_h < h - xh - sh$, and $m_h < -xh + a - s(h+1)$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w > xh - w - m_w - s(h+1)$, $c_h < h - xh - sh$, and $m_h < -xh + a - s(h+1)$

iii. $xh - s < m_w < xw - s$, $c_w > xh - w - m_w - s(h+1)$, $c_h < h - xh - sh$, and $m_h < -xh + a - s(h+1)$

2. ((¬IA),(I,D))

**Equilibrium**: $\alpha_2 = 1, \beta = 1, \theta_3 = 1$ (the value of other $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w < w - xw + sw$, $c_h > h - xh - sh$, and $m_h < -xw + a - s(w+1)$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w < w - xw + sw$, $c_h > h + xw + s(w+1)$, and $m_h < -xw + a - s(w+1)$

iii. $xw - s < m_w < xh - s$, $c_w < w - xw + sw$, $c_h > h + xw + s(w+1)$, and $m_h < -xw + a - s(w+1)$

3. ((¬IA),(¬I,D))

**Equilibrium**: $\alpha_2 = 1, \beta = 0$ (the value of $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w > w - xw + sw$, $c_h > h - xh - sh$, and $m_h < a - s$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w > w - xw + sw$, $c_h > h - xh - sh$, and $m_h < a - s$

iii. $xw - s < m_w < xh - s$, $c_w > w - xw$, $c_h > h - xh - sh$, and $m_h < a - s$

iv. $xh - s < m_w < xw - s$, $c_w > w - m_w - s$, $c_h > h - xh - sh$, and $m_h < a - s$

v. $m_w < min\{xh, xw\} - s$, $c_w > w - m_w - s$, $c_h > h - xh - sh$, and $m_h < a - s$

4. ((¬I¬A),(¬I,¬D))

**Equilibrium**: $\alpha_3 = 1, \beta = 0$ (value of $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw$, $c_w > w$, $c_h > h - xh + a - m_h - s(h+1)$, $m_h > a - s$, and $m_h > h - c_h - xh + a - s(h+1)$

ii. $\max\{xh, xw\} - s < m_w < xh + xw - s$, $c_w > w$, $c_h > h - xh + a - m_h - s(h+1)$, $m_h > a - s$, and $m_h > h - c_h - xh + a - s(h+1)$

iii. $xw - s < m_w < xh - s$, $c_h > h + a - m_h$, $m_h > a - s$, and $m_h > h - c_h + a$

iv. $xh - s < m_w < xw - s$, $c_h > h - xh + a - m_h - s(h+1)$, $m_h > a - s$, and $m_h > h - c_h - xh + a - s(h+1)$

v. $m_w < min\{xh, xw\} - s$, $c_h > h + a - m_h$, $m_h > a - s$, and $m_h > h - c_h + a$

5. ((I¬A),(¬I,¬D))

**Equilibrium**: $\alpha_4 = 1, \beta = 0$ (the value of $\theta$s is either 0 or 1)

**Conditions**:

i. $m_w > xh + xw - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > -xh + a - s(h+1)$

ii. $\max\{xh, xw\} < m_w < xh + xw$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > -xh + a - s(h+1)$

iii. $xw - s < m_w < xh - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > a$

vi. $xh - s < m_w < xw - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > -xh + a - s(h + 1)$

v. $m_w < min\{xh, xw\} - s$, $c_w > w$, $c_h > h - a + m_h + s$, $m_h > -h + c_h + a - s$, and $m_h > a$