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Market and Non-Market Exchange and Market-Supporting Institutions

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Abstract

Does market exchange reduce participation in non-market exchange thus reducing overall welfare? Some have argued that markets strengthen the necessary conditions for a vibrant non-market exchange, while others contend that markets promote individualism and alienate individuals, displacing social ties and, consequently, crowding out non-market exchange. This paper shows that having access to market and non-market exchange is welfare-enhancing despite the crowding out that may occur. Furthermore, there are conditions under which improvements in the quality of market-supporting institutions lead to increases in both market and non-market exchange mitigating any crowding out and improving overall welfare. Thus, an efficient economy with a combination of market and non-market exchange is crucial for achieving higher well-being compared to a pure non-market exchange economy.

Keywords: Market Exchange, Non-Market Exchange, Complementarity, Market-supporting Institutions, Community Enforcement.

JEL-Classification: D2, D3, C72, C73, D23, D73, H11, K12, O17, P48, P51, Z12

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"The market community is the most impersonal relationship of practical life into which humans can enter with one another." And, "where the market is allowed to follow its own autonomous tendencies, its participants do not look toward the persons of each other ... there are no obligations of brotherliness or reverence, and none of those spontaneous human relations that are sustained by personal unions" (Weber, 1921, p. 76)

1 Introduction

There is a long-standing debate about whether well-functioning market exchange crowds-out non-market exchange.[1] Coase (1937) and Williamson (1985) contend that market-supporting institutions serve to limit transaction costs; that is, they save time and money spent locating trading partners, facilitate price and quality comparisons, enforce trade agreements, and permit an efficient settling of controversies. In short, they make markets more efficient.[2] McCloskey (2006) sustains that these also boost trust and social capital and, therefore, non-market exchange. Writers such as Paine, Hume, Montesquie, and Condorcet have argued that markets reinforce durable and peaceful relations which favor non-market exchange. However, since Karl Marx argued that markets promote individualism and corrode traditional values, scholars such as Weber (1921), Polanyi (1944), Anderson (1995), Sandel (2012), and Satz (2010) have advanced that the pervasive presence of markets changes moral values, culture, and institutions in a way that displace social ties and, thereby, non-market exchange.[3] The empirical and anecdotal evidence is mixed.[4]

The focus of this paper is the coexistence and interaction between market and non-market exchanges when the participation choice is endogenous, payoffs are independent of each other and individuals have a access to a spot credit market. We explore a novel mechanism that links the two types of exchange with market supporting institutions and investigate the welfare effects of this mechanism. The main argument of the paper is that when market institutions are efficient, they increase the returns to market exchanges, which in turn give people more resources they can freely spend on both market and non-market exchanges. Even though some crowding out may occur, this crowding out is welfare enhancing when market supporting institutions are efficient.

[1] Non-market exchange refers to the exchange of goods and services that takes place outside of the market. This can include bartering, gift-giving, and sharing economy transactions. These types of exchanges are often based on social relationships and may not involve the use of money. They can also be found in traditional, subsistence-based societies where a market economy does not exist. Market-supporting institutions are organizations that provide the rules and regulations necessary to ensure the efficient operation of markets. They include regulatory bodies, market infrastructure, and financial intermediaries. Regulatory bodies are responsible for setting rules and regulations that ensure the safety of markets and protect investors. Market infrastructure refers to the physical and technological infrastructure necessary for markets to function, such as exchanges, clearinghouses, and depositories. Financial intermediaries are institutions that serve as intermediaries between buyers and sellers, such as banks, brokers, and dealers.

[2] See, e.g., McMillan (2002) for a detailed discussion on this.

[3] See, Besley (2013) for a criticism of Sandel's (2012) arguments, and Hirschman's (1982) for the so-called self-destruction thesis, which asserts that markets, with their strong emphasis on individual self-interest, undermine traditional values including those on the basis of which the market itself is working and, thereby, result in self-destruction.

[4] See, for instance, Gagnon and Goyal (2017) for real life examples.

Consider a setting in which people repeatedly choose to participate in both market and non-market exchanges. Market exchanges are governed by market supporting institutions (the legal system) in the sense that deviations from agreed upon contract terms are monitored and punished by these institutions and participating in it requires to pay a fixed cost. On the other hand, non-market exchanges are governed by community actions, so that deviations are punished by community sanctions as in a prisoner's dilemma game, thus capturing the personalized and reciprocal nature of non-market exchange.[5] This implies that the payoff to non-market exchange depends strategically on the actions chosen by other actors while the marginal payoffs to market exchange depend only on individual actions and the quality of market supporting institutions.[6] In this setting, market exchange and the quality of market supporting institutions do not have a direct effect on the payoffs of non-market exchange, but may have indirect effects as they may alter the payoff to deviation in non-market exchange. On the other direction, individuals who renege in non-market exchange, can continue their activity in the market without punishment, which insulates market exchange payoff from non-market activity.

How does market supporting institutions then affect non-market exchange? In a purely non-market exchange economy, individuals play grim trigger strategies and they choose between the largest self-sustainable non-market action and the welfare-maximizing market action whenever endowments allow it. Otherwise, they invest all their resources in it. In this economy, market supporting institutions have no bearing on the equilibrium.

When market exchange is also available, which makes borrowing in the spot credit market possible, and market institutions are adequately efficient, individuals have more of an incentive to co-operate in non-market exchange as their resource constraint relaxes.[7] At the same time, market exchange can harm non-market exchange by making the punishment for reneging less severe relative to that in the case in which market exchange is not available. Simultaneously, borrowing also facilitates participation in market exchange both in the extensive and intensive margins.

When looking at initial endowments, interesting parameter regions arise. There are two thresholds; a low and a high threshold. If the initial endowment is higher than the upper bound (the wealthy income case), individuals participate in both market and non-market exchanges, and there is no crowding out because the resource constraints are loose and incentives to participate, at a given intensity, in non-market exchange are not harmed by the possibility to engage in market exchange

[5] The result holds under assumptions of public monitoring and random matching, as long as the number of participants is not too large. In models where a social network determines trade possibilities and information flows, under specific network architectures, the result holds, but introducing these complexities may not offer additional intuition. See Wolitzky (2013).

[6] The results are robust to making the marginal payoff of market exchange dependant on other actors' actions as in non-competitive markets.

[7] To keep the analysis as simple as possible, we neither allow for savings nor for relationship lending. Hence, each period is identical to the preceding one and thereby we keep the model within the realm of repeated games.

after reneging. This is not a particularly revealing case because the interaction between the two exchanges is not constrained and strategic complementarities do not arise.

When the initial endowment is lower than the lower threshold (the lower income case), individuals only engage in non-market exchange because the cost of participating in market exchange is too high. In terms of welfare, individuals are better off than in a purely market exchange economy, since non-market exchange allows them to escape autarky due to the low income and high fixed costs of participating in market exchange. However, they are worse off than in a purely non-market exchange economy when the equilibrium in a purely market-exchange economy entails participating in market exchange. This happens because the possibility to engage in market exchange after reneging decreases the punishment power of trigger strategies. This lowers the non-market action when the incentive constraint binds. When the equilibrium in a purely market-exchange economy entails opting out of the market, individuals are equally well off in a purely non-market exchange economy than in an economy in which both types of exchange are available.

The case where the initial endowment falls between the two thresholds (the middle income case) is the more interesting one. Here, individuals participate in both exchanges but with some crowding out occurring.[8] First, a sufficient endowment makes participation in the market exchange possible as individuals are wealthy enough to pay the fixed cost of doing so. Entry to market exchange, on the margin offers a profitable investment relative to non-market exchange thus crowding out investment in the latter. However, ceteris-paribus, this crowding out is welfare improving because it allows for substitution towards a more efficient use of funds.

Now consider the case in which individuals have access to a perfectly competitive spot borrowing market but they can renege on some portion or all of the borrowed amount due to the non-contractibility of investments, thus introducing moral hazard in the borrowing market. Because the payoff from market exchange can be pledged to outside investors, while the payoff from non-market exchange cannot, a higher payoff from market exchange results in a higher borrowing capacity. Therefore, market exchange allows for borrowing and, consequently, more resources to be invested in both market and non-market exchange. Despite the independence of the payoffs from non-market and market exchange, they become linked through both the incentive-compatibility constraint regarding non-market exchange and the incentive-compatibility constraint regarding borrowing. This is a very important mechanism in the paper, market exchange creates income that can be pledged towards borrowing funds, and as market institutions improve, the amount available to be pledged increases, thus increasing resources to be spent in both exchanges. If moral hazard problems are particularly severe however, improvements in market-supporting institutions may actually

[8]Crowding out here is comparing the level of participation in the case where both exchanges are active with the case were only one of the markets is available.

reduce participation in non-market exchange because income pledgeability is low, market exchange becomes more profitable, and the punishment payoff upon reneging rises as institutions improve.

These results show that, under certain conditions, an improvement in formal institutions that facilitate market exchange and efficient capital markets results in more resources spent in market exchange and this can actually increase involvement in non-market exchange, even when crowding out occurs. Institutions that improve the efficiency of market exchanges have, through the capital market, a positive spillover effect in non-market exchanges and enhance overall welfare.

Our results provide insights into long-term economic development and emphasizes the crucial role of market supporting institutions. Given the complementarity highlighted in our analysis, strong markets can actually enhance non-market exchange rather than impede it. Therefore, for more effective economic modernization and the maintenance of efficient levels of non-market exchange, governments may find it beneficial to invest in robust market supporting institutions. Our analysis shows that it is welfare maximizing to invest in the quality of market supporting institutions, particularly when initial endowments are not excessively large. Despite the potential need for higher taxes to finance these improvements, the overall welfare gains justify the investment.

The rest of the paper is structured as follows. The next Section briefly discusses the related literature. Section 3 presents the model. Section 4 presents two benchmarks: the equilibrium in a purely non-market exchange economy and the equilibrium in a purely market-exchange economy. In Section 5, we derive the sub-game perfect equilibrium of the repeated game when both exchanges are available. In Section 6, we study welfare and complementarity/substitutability between market and non-market exchange. In the next Section, we discuss the robustness of the results. Section 8 concludes.

2 Related Literature

There is a theoretical literature studying the relationship between formal and community enforcement. For instance, Kranton (1996), Dixit (2003a,b), Acemoglu and Jackson (2017), and Jackson and Xing (2021), Wolitzky (2013), Acemoglu and Wolitzky (2020, 2021). Most of these papers introduce some kind of formal enforcement in repeated games models and study how the introduction of a particular type of formal enforcement crowds out community enforcement. For instance, Acemoglu and Wolitzky (2020, 2021) add agents specialized in coercive enforcement to a standard community enforcement repeated game model. The first one studies what sub-game perfect equilibrium maximize cooperation and show that grim triggers strategies fail to do so because they do not induce enforcement by specialized agents. The second uses the same model to study the emergence of legal equality. Dixit (2003a) shows that community enforcement can do worse than formal government enforcement in large size communities, the opposite occurs in small communities, and mid-size communities fare worst.[9]

Kranton (1996) shows that introducing market exchange undermine reciprocal exchange since opportunities for market exchange reduce the punishment for breaching a reciprocal-exchange agreement and provide access to new and different goods, which lowers search cost when the majority choose anonymous markets and rises them when few engage in them.[10] The fact that a more efficient market exchange undermines non-market exchange is also present in our model. However, Kranton's (1996) rests on search costs, goods variety, and the fact that both types of exchange are mutually exclusive, while our mechanism depends on anonymous markets increasing borrowing capacity and therefore resources to invest in both types of exchange.

Jackson and Xing (2021) in a repeated-task model with market and community tasks show that community and formal enforcement are complements.[11] This stems from the fact that the news that someone was found out cheating on a market task results in a community punishment consisting on ostracism, which strengths incentives to comply in the market task and gives rise to the complementarity between formal and informal enforcement.[12]

As we do, they derive the welfare maximizing institutions and, as in Kranton (1996), participating in the market or community task are mutually exclusive, while in our model, individuals are allowed to participate in both market and non-market exchange. In contrast to them, ostracism in market exchange plays no role in our complementarity result in the sense that behavior in market exchange cannot be punished. Thus, these two papers propose different economic mechanisms than the one studied here and as such we see them as complementarity to ours.

Gagnon and Goyal (2017) ask a similar question but in a static network game where neither community self-enforcing punishment nor the scarcity of resource play a role. The game considers a market and non-market task in which individuals decide whether to engage in one of the two. The individual payoff of the non-market action depends on how many neighbors choose the non-market action and whether or not he undertakes a market action. The equilibrium depends on whether the network and market action are complements or substitutes, which is an exogenous parameter that fully determines this. They discuss several real-life interesting examples regarding when actions are complements or substitutes.

[9] There is a growing theoretical and empirical literature that explores the interaction between formal and relational contracting asking whether informal and formal contracting are either substitutes or complements. This literature shows at both the theoretical and the empirical level that whether formal and informal contracting are complements depends on the institutional setting studied. See, Corts (2018) for a detailed review o this literature.

[10] In her model the participation in reciprocal exchange is random and fixed at the beginning of the game and individuals cannot participate in both market and non-market exchange.

[11] Agents are randomly assigned to either community task or market task and thereby they can never choose to participate in both.

[12] In the papers of Ali and Miller (2022) and Acemoglu and Wolitzky (2024), ostracism also plays a crucial role.

Lowes, Nunn, Robinson, and Weigel (2017) find that centralized formal institutions are associated with weaker norms of rule following and a greater propensity to cheat for material gains. This is consistent with having a less severe punishment from reneging in non-market exchange. Greif and Tabellini (2017) also argue in favor of substitution in their study of China versus Europe. They conclude that the European system has a comparative advantage in supporting impersonal exchange, while the Chinese system has a comparative advantage in economic activities in which personal relations are more important. In contrast, Poppo and Zenger (2002) find evidence, using data from a sample of information service exchanges, that supports the complementarity between formal and informal enforcement. Namely, managers appear to couple their increasingly customized contracts with high levels of relational governance and vice versa. Again these apparently contradictory predictions could be explained within the confines of our model in light of the different institutional settings in which they take place.

There is also evidence that the introduction of a formal credit market can erode social relationships and non-market exchange, as seen in Banerjee, Breza, Chandrasekhar, Duflo, Jackson, and Kinnan (2021) and Heß, Jaimovich, and Schündeln (2020). The latter also finds that market exchange rises with the introduction of a formal credit market. This is consistent with our model when the capital market is riddled with moral hazard problems.

There is plenty of evidence of how formal enforcement, formal markets and states, can function well on a large scale under the proper circumstances (Acemoglu, Johnson, and Robinson (2001b), Persson (2002), Tabellini (2010), and Besley and Persson (2010)), and those institutions can be either enhanced or hampered by culture understood as beliefs and values (Bisin and Verdier (2017) and Alesina and Giuliano (2015)) or co-evolve with culture (see Aghion, Algan, Cahuc, and Shleifer (2010), Pinotti (2012), and Bidner and Francois (2011)). Acemoglu, Johnson, and Robinson (2001a) argue that the roots of development are based on the role of formal institutions. Greif (2006) studies the process of institution formation in European history. Aghion, Alesina, and Trebbi (2004) look at the formation of political institutions and its distributional effect. Becker, Boeckh, Hainz, and Woessmann (2016) find that the Habsburg Empire, with its well-respected administration, increased the citizens' trust in local public services.

Our paper differs from the previous literatures in that it provides a novel strategic link between market and non-market exchange and market-supporting institutions in a setting where, a-priori, they are independent from each other and both types of exchanges generate benefits and compete for funds, rather than looking at circumstances under which either of them flourish. The economic mechanism under which market and non-market exchange are strategically related is new and rests on the quality of market-supporting institutions as well as income levels–observable variables that have been shown to be empirically important determinants of the degree of development of different economies–.

3 The Model

We consider a repeated game between $n+1$ individuals, each having a common discount factor δ. The primary objective for individuals is to maximize their consumption at the end of each period. In every period $t = 0, 1, 2, \ldots$, individuals participate in the following sequential game: At the onset of each period t, every individual is endowed with resources amounting to w. Subsequently, they simultaneously access the spot credit market, where they can request a loan that must be repaid by the end of the period. Simultaneously, they determine the amount of their own funds and borrowed funds to divert and convert into private benefits. After this diversion, individuals concurrently decide how much of the remaining resources (un-diverted) to invest in one or both of the following actions: a non-market action and a market action. Once returns are realized, debts are repaid, and net returns along with diverted and uninvested resources are fully consumed. There are no savings possibilities, and debt maturity is limited to one period

Non-market Exchange In each period t, if individual i invests $x_i \in \Re_+$ in the non-market action, he gets a payoff $-x_i$ and his investment benefits every other individual $j \neq i$ by an amount $f(x_i)$, where $f : \Re_+ \to \Re_+$ is an increasing, strictly concave, bounded, and differentiable function satisfying $f(0) = 0$. The strategy profile $x = (x_1, \ldots, x_n)$ is observable by each individual of the society. This implies that peer sanctions are possible; in their absence, individuals will not be willing to invest in the non-market action.

Two examples of this type of actions are: (i) crowdfunding, where people invest despite the fact that these types of projects are riddled with moral hazard problems and, thus, self-enforcing of agreements is needed for their success;[13] and (ii) rotating savings and credit associations (Roscas), which are informal financial institutions found all over the world and these institutions are primarily used to save up for the purchase of durable goods (see Besley, Coate, and Loury (1993) for a model of Roscas).

Market Exchange In each period t, if individual i invests $y_i \in \Re_+$ in the market action, he gets a payoff $g(y_i; \psi) - y_i$, and $\psi \in \Re_+$ is a parameter that measures the efficiency of the market in sense it will defined afterwards. The market payoff it is assumed to be independent of other individuals' investments.[14] Thus, a crucial feature of market exchange is that enforcement is formal and not community driven. The payoff function is strictly increasing in y_i, twice-continuously differentiable, strictly concave, and satisfies the following: $g_i(0; \psi) > 1$. This ensures that is

[13] Moysidou and Hausberg (2020) empirically study how trust works in this kind of projects. Agrawal, Catalini, and Goldfarb (2015) show how crowdfunding platforms play an important role in diminishing distance-sensitive costs. Chang (2020) provides a theoretical explanation about the economic forces behind crowdfunding projects and the willingness to invest in them despite the moral hazard problem.

[14] It might help to think of $g(y_i; \psi) = g(y_i; \int_0^m y_j dj; \psi)$, where m is the mass individuals participating in market exchange, including those outside of the community.

individually optimal in an static equilibrium to invest a positive amount in the market action and the second one implies that is optimal for each individual to invest a positive amount in the market action. Furthermore, $g(0;\psi) = 0$, $g_{\psi}(\cdot) > 0$, and $g_{i\psi}(\cdot) \geq 0$. Hence, as ψ rises, the marginal payoff as well as the payoff itself increases. Because of this, the inverse of ψ could represent, for instance, regulations affecting the firm's efficiency, such as taxes levied on actions, or regulations that impose rigidities in the relationship between employers and employees. It also could capture the probability that the payoff takes place as agreed on. Participating in market exchange entails a fixed cost per individual equal to ξ. The lower ξ, the higher the quality of market-supporting institutions since this makes cheaper to participate in the formal market.

Credit Market There is a spot credit market in placed. As in Shleifer and Wolfenzon (2002), Burkart, Panunzi, and Shleifer (2003), Burkart and Panunzi (2006), Burkart and Ellingsen (2004), and Balmaceda, Fischer, and Ramirez (2014), there is ex-ante moral hazard in the credit market. This means that individuals can engage into resource diversion; that is, utilize (either partially or entirely) the available resources, consisting of their endowment and borrowed funds, to generate non-verifiable private benefits. For each dollar that an individual diverts, only a fraction $\phi \in [0, 1)$ is realized as a private benefit. The remaining portion is lost in the diversion process. Therefore, ϕ serves as the level of creditors' protection – when $\phi = 0$, creditors are fully protected, allowing the financing of any investment with a positive present value. In the context of our model, ϕ should be interpreted broadly, encapsulating the entire justice system, including the strength of property rights and laws, the monitoring capabilities of the legal system, and its enforcement of laws and property rights. Consequently, incomplete creditor protection is another fundamental market institution.

Market returns are fully verifiable, allowing them to be pledged to external investors, while investments are non-contractible. Non-market returns are non-verifiable.[15] Due to this, individuals receive these returns only after fulfilling all repayment obligations. If all resources are diverted, no investment takes place, and nothing is repaid.

Because payoffs are certain, financial contracts stipulates a non-contingent repayment r_i in exchange for an amount of external funds d_i. Capital markets are assumed to be perfectly competitive. The model excludes relationship lending and savings options, ensuring its alignment with the realm of repeated games.

Main Features of the Model Firstly, the model is a highly stylized representation of a community, where a notable feature is that non-market exchange can only be sustained as an equilibrium outcome of a game structured like a Prisoners' Dilemma. Thus, non-market exchange doesn't emerge from inherent characteristics of individuals, such as trustworthiness; rather, it results from individ-

[15] We could have assumed that non-market returns are partially verifiable, but this will not change the results and will add notational burden.

uals' self-interested enforcement mechanisms made possible through repeated interactions. This definition aligns with the perspectives of Coleman (1990) and Putnam (2000), wherein non-market exchange involves investments in non-contractible actions motivated by self-interest and enforced through community sanctions.

Secondly, the model deliberately excludes considerations of savings to maintain simplicity and keep it within the framework of repeated games. Allowing for savings would alter the recursive structure of the model, making the equilibrium analysis of the investment game more intricate without necessarily enhancing our understanding of the relationship between market and non-market exchange and market-supporting institutions.

Thirdly, the assumption has been made that the payoff from the non-market action is independent of the payoff from the market action. This intentional choice avoids establishing a mechanical relationship between non-market exchange, market exchange, and market-supporting institutions. However, as the subsequent analysis will reveal, a strategic relationship between them will emerge in the dynamic game.

These modeling choices collectively contribute to a simplified yet insightful framework for examining the intricate dynamics between market and non-market exchange, as well as their interaction with market-supporting institutions.

4 Benchmarks

4.1 A Purely Non-Market Exchange Economy

In a purely non-market exchange economy, individuals engage exclusively in non-market exchange activities. Market exchange is entirely absent, and the allocation of resources is determined solely through non-market interactions within the community. This scenario represents a system where formal market mechanisms and external institutions do not play a role in resource allocation, and individuals rely on community-based enforcement and cooperation for their economic interactions. The absence of market implies that neither market exchange nor credit transactions can occur. Also formal enforcement is not possible. Consequently, in this scenario, upon deviation, an individuals is forced to live in autarky, and his payoffs is limited to his endowment w. This is the harshest possible punishment.

When individuals play grim-trigger strategies, each agent's investment in the non-market action $x_i \in \Re_+$ is incentive compatible in each period, provided that other individuals' action profile is

x_{-i}, if and only if agent i prefers to invest x_i than investing zero; that is,

$$\begin{aligned}
&\sum_{j\neq i} f(x_j) + w - \min\{x_i, w\} \geq (1-\delta)\big(\sum_{j\neq i} f(x_j) + w\big) + \delta w \\
&\implies \qquad (1)\\
&\min\{x_i, w\} \leq \delta \sum_{j\neq i} f(x_j).
\end{aligned}$$

Let's define $x(\delta)$ as the largest symmetric solution to the incentive constraint when we ignored the resource constraint; that is, $x_i \leq \delta \sum_{j\neq i} f(x_j)$, and $x^{fb} \equiv \text{argmax}_{x\in\Re_+^{n+1}} \sum_{i=1}^{n+1}\{\sum_{j\neq i} f(x_j) - x_i\}$. Observe that $x(\delta)$ rises with δ and therefore there exits a threshold δ^{fb} such that $x(\delta) \leq x^{fb}$ for all $\delta \leq \delta^{fb}$.

Because repeated games have multiple equilibria, from here onwards, we focus on the welfare-maximizing and incentive-compatible equilibria.[16]

The non-market action profile solves the following problem

$$\begin{aligned}
&\max_{x\in\Re_+^{n+1}} \sum_{i=1}^{n+1} \Big\{ \sum_{j\neq i} f(x_j) + w - x_i \Big\} \\
&\text{subject to} \\
&x_i \leq \min\{w, x(\delta), x^{fb}\}
\end{aligned}$$

When individuals face no resource constraints, the non-market action that maximizes welfare involves selecting the minimum action between the unconstrained welfare-maximizing amount and the largest incentive-compatible amount. Conversely, when the endowment is insufficient to finance this amount, it is welfare-maximizing to allocate the entire endowment to the non-market action. Therefore, the following result is derived.

Proposition 1. *The optimal investment in the non-market action is* $x^n = \min\{w, x^{fb}, x(\delta)\}$ *and is non-decreasing in* δ*.*

Let's define the endowment level $w^n = \min\{x^{fb}, x(\delta)\}$.[17] Thus, whenever $w \leq w^n$, $x^n = w$. Because individuals are symmetric, welfare is given by $n+1$ times the individual's equilibrium payoff

$$V^n = \begin{cases} nf(\min\{x^{fb}, x(\delta)\}) + w - \min\{x^{fb}, x(\delta)\} & \text{if } w > w^n, \\ nf(w) & \text{if } w \leq w^n. \end{cases} \qquad (2)$$

[16]In 7, we argue that our results are robust to other equilibrium-selection criteria.

[17]The superscript n stands for non-market exchange.

It is straightforward to see that as the endowment rises, the equilibrium payoff increases monotonically. In fact, $V_w^n \geq 1$. In addition, the equilibrium payoff and the endowment threshold $w(\delta)$ are both non-decreasing in δ.

4.2 A Purely Market-Exchange Economy

Here, we derive the sub-game perfect equilibrium of the repeated static game when non-market exchange is not available. There are two important features of this equilibrium. First, the equilibrium payoff in this game will be the same as the equilibrium payoff during the punishment phase in a market and non-market exchange economy. Second, the equilibrium payoff of this game is identical to the payoff of the static equilibrium of an economy that allows for both non-market and market exchange. This results from the fact that an individual's benefit from non-market exchange is independent of his own action, the cost of it is increasing in it, and community punishments are not applicable in a static game.

Let k_i be individual i's non-divested resources and m_i his decision to participate in market exchange. Individual i will solve the following problem[18]

$$\max_{(y_i,m_i)\in\Re_+^2\times\{0,1\}} \left\{ m_i(g(y_i;\psi) - y_i - \xi) + k_i - r_i \right\}$$

$$\text{subject to}$$

$$m_i(y_i + \xi) \leq k_i.$$

Let's denote the unique solution to $g_i(y_i;\psi) - 1 = 0$ by y^{mu} and define $k^{mu} \equiv y^{mu} + \xi$.[19] In what follows, we will assume that it is privately optimal to participate in market exchange when unconstrained; that is,

Assumption 1. $g(y^{mu};\psi) - y^{mu} - \xi > 0$.

It readily follows from this, that individual i's best-response function when he participates in market exchange is y^{mu} whenever $y^{mu} \leq k_i - \xi$; otherwise, it is given by $k_i - \xi$. When the agent does not participate in market exchange, he lives in autarky by consuming his resources and therefore $y = 0$.

Let $(y(k), m(k))$ be the optimal action profile when non-diverted resources are k. Let's define k^{mc} as the smallest k such that the payoff from opting out of market exchange yields a higher payoff

[18] Because each individual's payoff is independent of other individuals' actions, the welfare-maximizing equilibrium is identical to the equilibrium where each individual choose (y_i, m_i) to maximize his payoff.

[19] The superscript m stands for market exchange and u for unconstrained.

participating in it when the individual is constrained; i.e., $k_i = y_i + \xi$.[20] Thus, k^{mc} is the lowest k such that $k \geq g(k - \xi; \psi)$.[21] Hence, the discussion above leads to the following result.[22]

Proposition 2.

i) If $k \geq k^{mu}$, then $y(k) = y^{mu}$ and $m(k) = 1$. $y(k)$ is independent of k,

ii) If $k^{sc} \leq k_i < k^{mu}(\xi)$, then $y(k) = k - \xi$ and $m(k) = 1$. $y(k)$ rises with k.

iii) If $k < k^{mc}$, then $y(k) = 0$ and $m(k) = 0$.

Thus, when available resources are large enough so that it is worthwhile to pay the fixed cost of participating in market exchange, individuals do so and invest the minimum between $k - \xi$ and the payoff maximizing market action. Otherwise, they opt out of the market and save the fixed cost ξ but give up the return $g(y; \psi) - y - \xi$.

Because lenders anticipate individuals' investment strategy $(y(k), m(k))$ and that they can divert with borrowed and own funds, they must lend them an amount that does not induce them to divert. Given that the returns are certain and the diversion technology is such that it allows to enjoy a constant share of diverted resources as private benefits, diversion is an all-or-nothing decision.[23] Hence, individuals prefer to invest the money than diverting with it whenever

$$m_i(k)(g(y_i(k); \psi) - y_i(k) - \xi) + d_i + w - r_i \geq \phi\big(d_i + w\big). \tag{3}$$

Because the credit market is perfectly competitive, in equilibrium, lenders must make zero profits in each contract and thereby $d_i = r_i$. Thus, individual i solves the following problem,

$$\max_{d_i \in \Re_+} \{m_i(k)\big(g(y_i(k); \psi) - y_i(k) - \xi\big) + k_i - r_i\}$$
$$\text{subject to}$$
$$d_i \leq \phi^{-1}\big(m_i(k)(g(y_i(k); \psi) - y_i(k) - \xi) + (1 - \phi)w\big).$$

It readily follows from this that in the symmetric equilibrium, the optimal debt is zero when $w \geq y^{mu} + \xi$. Otherwise, debt is positive to be able to participate in market exchange and to finance y^{mu}.

[20] The superscript mc stands for market constrained.

[21] Its existence follows from the Intermediate Value theorem since $g(k - \xi; \psi) - k$ is continuous in k, negative in $k = 0$, and positive for $k = y^{mu} - \xi$.

[22] Formal proofs can be found in the Appendix.

[23] The more detailed argument why partial diversion is dominated is the following: On one hand, if the individual plans to repay the loan in full, the marginal benefit from investment is at least 1 –higher than one if he is constrained–, which is larger than the marginal benefit from diversion, which is ϕ. On the other hand, if the individual were to invest too little to repay the loan in full, there is no point in investing any resources at all, since any additional return would be claimed by the bank. Furthermore, if the individual diverts borrowed funds, he should also divert his own funds. Otherwise, these will be claimed by the creditor upon default.

Because there is neither a gain nor a loss from borrowing more than it is needed, without loss of generality, we can assume that individuals borrow exactly the amount needed to finance the desired level of investment $y^{mu} + \xi$, after contributing its own funds; that is, $d = \xi + y^{mu} - w$. When this is not possible and individuals wish to participate in market exchange, they borrow as much as possible. This establishes a one-to-one relationship between debt and investment. Thus, the maximum incentive-compatible debt solves borrowing incentive-compatibility constraint in (**??**) with equality. Let's denote this when the individual participates in market exchange by d^{mu}.[24]

To make the problem interesting, from here onwards, we will assume that the quality of capital-market institutions (ϕ) is such that individuals whose endowment is zero cannot borrow enough to participate in market exchange and to choose the unconstrained investment level; that is,

Assumption 2. $\phi > \phi^m \equiv \frac{g(y^{mu};\psi)}{y^{mu}+\xi} - 1$.

From the preceding discussion and results, we deduce the sub-game perfect equilibrium, which is given by

Proposition 3.

$$(x^m, y^m, m^m) = \begin{cases} (0, y^{mu}, 1) & \text{if } w \geq w^{mu}, \\ (0, w + d^{mu} - \xi) & \text{if } w^{mc} \leq w < w^{mu}, \\ (0, 0, 0) & \text{if } w < w^{mc}. \end{cases}$$

The equilibrium is such that when the endowment is too small, individuals refrain from participating in market exchange, choosing instead living in autarky. Otherwise, they participate in market exchange and invest all resources when constrained or the payoff maximizing amount when unconstrained. This occurs when $w \geq w^{mu}$.

The existence of the different thresholds follows, as shown in the appendix, from the fact that the marginal return to market exchange for a constrained individual is higher than $1 + \phi$ and the continuity of the payoff with respect to the action $y(k)$ despite the fact that this is not continuous in k since when the individual decides to opt out of the market $y(k)$ drops from $k - \xi$ to zero.

In the next proposition, we derive the comparative statics with regard to (ϕ, ψ, w, ξ).

Proposition 4.

i) If $w \geq w^{mu}$, y^m increases with ψ and is independent of (ϕ, w, ξ).

ii) If $w \in [w^{mc}, w^{mu})$, y^m increases with (ψ, w) and falls with (ϕ, ξ).

[24]Observe that when $m(k) = 0$, an individual could eventually borrow the highest incentive compatible debt, which is $(1 - \phi)\phi^{-1}w$, but this is of no use since he chooses not to participate in market exchange and hence he is indiferent between borrowing and not borrowing any money. In both cases his payoff is w.

iii) if $w < w^{mc}$, y^m rises with w and is independent of $(\psi, \phi\xi)$.

The results with regard to ψ follow from the concavity of g, $g_\psi > 0$, and $g_{i\psi} \geq 0$. Hence, an increase in ψ impact the equilibrium market action because, holding this constant, it increases its payoff and therefore borrowing capacity and/or increases its marginal return. An increase in ϕ lowers the maximum that can be borrowed since borrowers' temptation to divert is higher. A rise in ξ decreases pledgable income, which lowers y^m when the individual is constrained. A larger endowment softens borrowing incentive constraint because the marginal return to the market action rises more than ϕ, which is the marginal return to diversion.

Because the equilibrium is symmetric, total welfare is $n+1$ times the static individual equilibrium payoff, denoted by V^m, and given by

$$V^m = \begin{cases} g(y^{mu};\psi) + w - y^{mu} - \xi & \text{if } w \geq w^{mu}, \\ (1+\phi)^{-1}\phi\big(g(w + d^{mu} - \xi;\psi) + w\big) & \text{if } w \in [w^{mc}, w^{mu}), \\ w & \text{if } w < w^{mc}. \end{cases}$$

Then, we have the following result.

Proposition 5. *Suppose Assumption 2 holds.*

i) If $w \geq w^{mu}$, $V^m_w = 1$, $V^m_\psi > 0$, $V^m_\phi = 0$, and $V^m_\xi < 0$.

ii) If $w \in [w^{mc}, w^{mu})$, $V^m_w \in (0,1)$, $V_\psi > 0$, $V^m_\phi < 0$, and $V^m_\xi < 0$.

iii) If $w < w^{mc}$, $V^m_w = 1$ and $V^m_\psi = V^m_\xi = V^m_\phi = 0$.

When individuals are rich, the equilibrium payoff increases with w because the market action is independent of w and thereby consumption rises. When individuals are neither rich nor poor, the equilibrium payoff rises with w since available resources rises with w as borrowing capacity rises with the endowment. When individuals are poor, they live in autarky, and an increase in the endowment results in more consumption.

When individuals are rich, an increase in ψ raises the market payoff when the market action is held constant and also rises the equilibrium market action since the marginal return is higher. When individuals are neither poor nor rich, the equilibrium payoff rises with ψ because, holding the action constant, the higher the ψ, the lager the market payoff and as a result borrowing capacity rises. When the community is poor, it lives in autarky, and debt is zero.

An increase in the intensity of moral hazard does not affect the payoff for both rich and poor individuals since they do not borrow any money but it decreases the payoff for individuals that are neither poor nor rich since the incentive constraint for debt toughens as ϕ rises, as the payoff from diverting increases. This lowers the market action profile.

An increase in the fixed cost of participating in the market lowers the equilibrium payoff whenever individuals participate in market exchange. Furthermore, it raises the endowment threshold below which individuals choose to live under autarky.

Hence, in a purely market-exchange economy, the equilibrium payoff is non-decreasing with the quality of market-supporting institutions (ϕ, ψ, ξ) and the threshold below which individuals are resource constrained and the one below which autarky is chosen fall with it.

5 A Market and Non-market Exchange Economy

5.1 The Equilibrium

Here, we study the repeated game in a market and non-market exchange economy where individuals play grim-trigger strategies that switch to play the equilibrium of a purely market-exchange economy after a deviation regarding non-market actions is observed.[25]

Because individuals play grim-trigger strategies, each individual's investment in the non-market action $x_i \in \Re_+$ is incentive-compatible in each period, provided that he chooses (y_i, m_i) and the strategy profile of the other individuals is (x_{-i}, y_{-i}, m_{-i}) if and only if individual i prefers to invest x_i than investing any other amount. Hence, the following must be satisfied:

$$\begin{aligned} & \sum_{j\neq i} f(x_j) - x_i + m_i(g(y_i;\psi) - y_i - \xi) + k_i - r_i \geq \\ & (1-\delta)\Big(\sum_{j\neq i} f(x_j) - x_i + m_i(g(y_i;\psi) - y_i - \xi) + k_i - r_i\Big) + \delta V^m \\ & \implies \\ & x_i \leq \delta\Big(\sum_{j\neq i} f(x_j) + m_i(g(y_i;\psi) - y_i - \xi) + k_i - r_i - V^m\Big), \end{aligned} \tag{4}$$

where V^m is the sub-game perfect equilibrium payoff of a purely market-exchange economy.

It readily follows from this that, ceteris-paribus, an increase in the equilibrium payoff of the purely market-exchange economy crowds out incentives to invest in the non-market action since deviations are more tempting.

From here onwards, we will focus on symmetric equilibrium. Let's define $x(\delta, y_i, m_i)$ as the largest solution to the incentive constraint in equation (4) when this exists, otherwise $x(\delta, y_i, m_i)$ is set to zero. Observe that $x(\delta, y_i, 1)$ increases with y_i for all $y_i \leq y^{mu}$ since the payoff from market exchange rises. It also increases with (δ, k_i). The former is due to the fact that an individual value the future more and therefore the loss from entering the punishment phase is higher. The latter is due to the fact that, ceteris-paribus, consumption rises.

[25] This is optimal in our setting since there is perfect monitoring. See, Wolitzky (2013). This is also the worst possible punishment.

Let's define δ^u as the lowest discount factor such that $x^{fb} = x(\delta, y^{mu}, 1)$.[26]

As it is the case in most repeated games, there are multiple equilibria, among which the repetition of the static equilibrium is one of them, the welfare-maximizing equilibrium, and the Pareto dominant equilibrium are others.[27] Our interest in characterizing the highest incentive-compatible welfare associated to different institutional settings satisfying individuals' resource constraints. Hence, we focus on the action profile (x, y, m) that solves the following problem

$$\max_{(x,y,m)\in\{\Re^2_+\cup\{0,1\}\}^{n+1}} \sum_{i=1}^{n+1} \Big\{ \sum_{j\neq i} f(x_j) - x_i + m_i(g(y_i;\psi) - y_i - \xi) + k - r \Big\}$$

subject to $\forall\, i$

$$x_i \leq \delta\Big(\sum_{j\neq i} f(x_j) - x_i + m_i(g(y_i;\psi) - y_i - \xi) + k - r - V^m \Big),$$

$$x_i + m_i(y_i + \xi) \leq k.$$

When resources are sufficiently large, the welfare maximizing action profile consists on choosing the market action that maximizes the market payoff $m_i(g(y_i;\psi) - y_i - \xi)$ and the minimum between the welfare-maximizing and the largest self-sustainable non-market action, which is the former whenever $\delta \geq \delta^u$.

Let's define $x^{nmu}(\delta) \equiv x(\delta, y^{mu}, 1)$. Then, this is feasible whenever $k_i \geq k^u(\delta) \equiv y^{mu} + \xi + \min\{x^{fb}, x^{nmu}(\delta)\}$.[28] Let $(x_i(k,\delta), y_i(k,\delta), m_i(k,\delta))$ be the optimal investment profile in this case.

When individuals do not have enough resources to implement this solution, the investments are determined by the following first-order conditions

$$x_i : \sum_{j\neq i} f_i(x_i) - 1 - \lambda_i + \mu_i(\delta \sum_{j\neq i} f_i(x_i) - 1) = 0,$$

$$y_i : g_i(y_i;\psi) - 1 - \lambda_i + \mu_i\delta(g_i(y_i;\psi) - 1).$$

where $\lambda_i \geq 0$ is the Lagrange multiplier for individual i's resource constraint and $\mu_i \geq 0$ is the Lagrange multiplier for individual i's incentive compatibility constraint. Let's denote the solution by $(x_i^c(k), y_i^c(k), m_i^c(k))$ and observe that $x_i^c(k) = k_i - y_i^c(k) - \xi$.

[26]Because $x(\delta, y, 1)$ rises with δ and $g(y^{mu};\psi) + k_i - y_i^{mu} - \xi - V^m \geq 0$ and f is concave, $\delta^u(\phi, \psi, k, w)$ exists and is unique.

[27]For instance, Balmaceda and Escobar (2017) study both the welfare and Pareto in a repeated network game, Wolitzky (2013) studies the welfare-maximizing strategy profile in a repeated network game, and Gagnon and Goyal (2017) study the Pareto equilibrium of a static network game. The collusion literature focuses mainly on sustaining the highest possible price, which is the monopoly price, and it is the welfare-maximizing equilibrium when welfare is defined as the sum of firms' profits (players' payoffs).

[28]The superscript n in mnu stands for non-market, the m for market exchange, and the u for unconstrained.

Finally, when resources are too small, individuals will opt out of market exchange to save on the fixed cost and will invest the totality of resources in the non-market action whenever this amount is lower than or equal to the minimum between the welfare-maximizing and the largest self-sustainable non-market action. Otherwise, they will invest $\min\{x^{fb}, x^{nmu}(\delta)\}$.

The preceding discussion leads to the following result.

Proposition 6.

i) There is a unique symmetric equilibrium in the action sub-game given by

$$(x(k), y(k), m(k)) = \begin{cases} (\min\{x^{fb}, x^{nmu}(\delta)\}, y^{mu}, 1) & \text{if } k \geq k^u(\delta), \\ (k - y^c(k,\delta) - \xi, y^c(k,\delta), 1) & \text{if } k \in [k^m(\delta), k^u(\delta)), \\ (\min\{k, x^{fb}, x(\delta, 0, 0)\}, 0, 0) & \text{if } k \in [0, k^m(\delta)). \end{cases}$$

ii) $(y(k), x(k), m(k))$ *are semi-continuous functions of k with a discontinuity at* $k = k^c(\delta)$.

When resources are abundant, welfare is maximized by choosing actions that maximize both market and non-market payoffs, ensuring incentive compatibility. In cases where resources are moderate, the optimal strategy involves equalizing the marginal return to market exchange with the marginal return to no market exchange, provided non-market exchange remains incentive-compatible. If not, it is welfare maximizing to opt for the largest incentive-compatible non-market action and to allocate the rest to the market action. Conversely, when resources are scarce, it becomes optimal to refrain from market exchange to avoid the fixed costs associated with it. A benefit of having the possibility to engage in non-market exchange is to avoid autarky, which will be the outcome in this case in a purely market-exchange economy. Hence, non-market exchange works as sort of insurance against low quality market-supporting institutions.

Because lenders anticipate that individuals can divert with the funds before investing, they limit borrowing capacity to the ones that are incentive compatible. Because, as before, diversion is an all-or-nothing decision, individuals prefer to invest the money than divert with it whenever[29]

$$m(k)(g(y(k);\psi) - y_i(k) - \xi) + d_i + w - r_i - x(k) \geq \phi\big(d_i + w\big). \tag{5}$$

One can draw a comparison between this incentive-compatibility constraint and the one arising in a purely market-exchange economy, as given in equation (3). The implication is that the option to participate in non-market exchange diminishes borrowing capacity relative to a purely market-exchange economy. This is due to the inherent unverifiability of investments, leading investors to

[29]Because $\sum_{j\neq i} f(x_j(k))$ is non verifiable, non-market returns cannot be pledged to outside investors and thereby they do not affect the incentive compatible debt level. Because $\sum_{j\neq i} f(x_j(k))$ is positive, if non-market returns were verifiable, they will soften the credit constraint.

anticipate that a portion of the lent funds will be directed towards non-market exchange, resulting in a non-verifiable return. Hence, having both types of exchange available, ceteris-paribus, reduces borrowing capacity when the investment in non-market exchange is positive.

Given that the credit market is perfectly competitive, in equilibrium, lenders must make zero profits in each contract and thereby $d_i = r_i$. It readily follows from this and the fact that individuals anticipate the equilibrium of the game that will be played in the action sub-game that they choose debt to solve the following problem

$$\max_{d_i \in \Re_+} \Big\{ \sum_{j \neq i} f(x_j(k)) - x_i + m(k)(g(y_i(k); \psi) - y_i - \xi) + k_i - r_i \Big) \Big\}$$

$$\text{subject to}$$

$$d_i \leq \phi^{-1}(m(k)(g(y_i(k); \psi) - y_i(k) - \xi)) - x_i(k) + (1 - \phi)\phi^{-1} w.$$

It readily follows from this that in the symmetric equilibrium, the optimal debt is zero if $w \geq \min\{x^{fb}, x^{nmu}(\delta)\} + y^{mu} + \xi$, otherwise, debt must be positive in order to be able to participate in the market and to finance y^{mu} and the non-market action $\min\{x^{fb}, x^{nmu}(\delta)\}$. Let's define the debt level d^{nmu} as $\max\{0, \min\{x^{fb}, x^{nmu}(\delta)\} + y^{mu} + \xi - w\}$. Because there is neither a gain nor a loss from borrowing more than it is needed, without loss of generality, we can assume that individuals borrows exactly the amount needed to finance the desired level of investment $\min\{x^{fb}, x^{nmu}(\delta)\} + y^{mu} + \xi$, after contributing its own funds. When this is not possible, individuals borrow as much as possible. This establishes a one-to-one relationship between debt and investment. The highest incentive compatible debt is given by the solution to the incentive compatibility with equality. Let's denote this by d^{nmc}. Observe that when $m = 0$, the optimal debt is zero.

Let $(x^{nmc}, y^{nmc}) = (x^c(w + d^{nmc}), y^c(w + d^{nmc}))$ for all $\delta > \delta^c(w + d^{nmc})$ and $(x^{nmc}, y^{nmc}) = (x(w + d^{nmc}, \delta), y(w + d^{nmc}, \delta)$ for all $\delta \leq \delta^c(w + d^{nmc})$.

The next result is deduced from Proposition 6 and Lemma 4.

Proposition 7. *The equilibrium profile regarding the market and non-market action is given by:*

$$(x^{nm}, y^{nm}, m^{nm}) = \begin{cases} (\min\{x^{fb}, x^{nmu}(\delta)\}, y^{mu}, 1) & \text{if } w \geq w^{nmu}, \\ (w + d^{nmc} - y^{nmc} - \xi, y^{nmc}, 1) & \text{if } w^{nmc} \leq w < w^{nmu}, \\ (\min\{w, x^{fb}, x(\delta, 0, 0)\}, 0, 0) & \text{if } w < w^{nmc}. \end{cases}$$

When individuals are rich, they select the welfare-maximizing non-market action if their patience level, δ, exceeds the threshold δ^{nmu}. Alternatively, if their patience falls short of this threshold, they opt for the largest self-sustainable non-market action. In either situation, they possess abundant resources to opt for the market action that maximizes their market payoff. When $\delta < \delta^{nmu}$, there is an underinvestment in the non-market action.

For individuals who are neither rich nor poor, two scenarios emerge. In the first scenario, their discount factor is such that it allows them to simultaneously choose the market and non-market actions up to the point where marginal returns are equalized across the two actions. This results in underinvestment in the non-market action, yet the investment remains positive. In the second scenario, the discount factor is low enough so the non-market action that has the same marginal return than the market action violates the non-market action's incentive compatibility constraint, prompting individuals to choose the highest incentive-compatible non-market action. Any surplus of resources is then invested in the market action. Thus, the marginal return of the non-market action exceeds that for the market action. In both cases, market exchange crowds-out non-market exchange relative to the purely non-market exchange economy.

Poor individuals opt out of market exchange due to the prohibitive fixed costs associated with participation. However, they avoid autarky by investing a portion or all of their resources into non-market activities.

Next, we derive the comparative statics with respect to the main parameters of interest (ϕ, ψ, w, ξ).

Proposition 8. *Suppose that $w \geq w^{nmu}$.*

i) x^{nm} is independent of (ϕ, ψ, ξ) and is non-decreasing with w.

ii) y^{nm} is independent of (ϕ, w, ξ) and rises with ψ.

When the initial endowment is large (i.e., $w \geq w^{nmu}$) and individuals place a high weight on the future; that is, $\delta \geq \delta^u$, the purely market-exchange economy equilibrium market action is chosen and the non-market action is the welfare-maximizing one and thereby the non-market action is independent of the market action and the market-supporting institutions (ϕ, ψ), while in rich communities where individuals are not as patient, the equilibrium non-market action is the largest self-sustainable non-market action and thereby this could in principle depend on the market-action level as well as the market-supporting institutions. However, because $w^{nmu} > w^{mu}$, the payoff from market exchange in the equilibrium of the market and non-market exchange economy; i.e., $g(y^{mu}; \psi) - y^{mu} - \xi$, is identical to that in a purely market-exchange economy; i.e., V^m. Hence, the non-market action's incentive compatibility constraint is independent of (ψ, ξ, ϕ) and so does x^{nm}. Because the equilibrium selected is such that the market action maximizes the market payoff, the market action rises with ψ since $g_i(y; \psi)$ rises with ψ.

Proposition 9. *If $w^{nmc} \leq w < w^{nmu}$*

i) y^{nm} rises with (ψ, w) and falls with (ϕ, ξ).

ii) x^{nm} *rises with* w*, falls with* (ϕ, ξ)*, and if* $g_{ii}(y;\psi)g_{\psi}(y;\psi)+g_{i\psi}(y;\psi)(1+\phi^m-g_i(y;\psi)) < 0$ *for all* $y \leq y^{mu}$*, then there exists an open set of parameters* Φ *such that* x^{nm} *increases with* ψ *whenever* $\phi \in \Phi$.

The market and non-market actions are complements when an improvement in the quality of a market-supporting institution increases both actions.

The comparative statics regarding y^{nm} are due to the fact that individuals are credit constrained, and $w + d^{nmc}$ rises with (ψ, w) and falls with (ϕ, ξ), and ψ increases the marginal return to the market action. The non-market action behaves in the same way as y^{nm} with respect to (ϕ, w, ξ), and therefore the market and non-market actions are complements with respect to them. Regarding the behavior of x^{nm} with respect to ψ, the result shows that the market and non-market action are complements when $g_{ii}(y;\psi)g_{\psi}(y;\psi) + g_{i\psi}(y;\psi)(1 + \phi^m - g_i(y;\psi)) < 0$ for all $y \leq y^{mu}$.

The behavior of x^{nm} with respect to any parameter depends on whether the non-market action is determined by its incentive compatibility constraint or the equalization of marginal returns across exchanges. An improvement in any market-supporting institution, holding actions constant, has two main effects: an increase in the payoff during the punishment phase, which tightens the non-market action's incentive constraint, and increases in pledgable income, which softens the borrowing constraint. This makes a larger non-market and a larger market action feasible.

When the non-market action's incentive constraint does not bind (i.e., $\delta > \delta^u$), the marginal return to the market action must be equal to the marginal return to the non-market action. Because an increase in w and a fall in (ψ, ξ) rise borrowing capacity, the extra funds are spent in both actions so as to equalize their marginal returns. A hike in ψ, holding actions constant, rises pledgable income, which increases borrowing capacity and rises the marginal return to the market action. Because the borrowing capacity binds, the two effects push the market action up, and the former pushes the non-market action up, and the latter pushes it down. Hence, when the trade-off between these two forces is resolved in favor of an increase in borrowing capacity larger than the increase in the market action, the non-market action rises.

This occurs when an increase in y results in the positive effect of ψ on the market payoff being lower when the borrowing incentive constraint binds. This situation arises when the impact of ψ on the market payoff, holding y constant, is significant compared to its impact on the marginal return to market action, and the marginal return to y is sufficiently concave so that increasing y is not highly profitable relative to the opportunity cost of investing in the non-market action. This opportunity cost depends on the quality of the capital market-supporting institution ϕ. When ϕ is such that the intensity of moral hazard is low (i.e., when ϕ is small), the pass-through from ψ to borrowing capacity is large. Consequently, the gain from investing the extra borrowing capacity in the market action versus investing them in both the market and non-market action, despite the fact that this implies a lower borrowing capacity, is not worthwhile.

When the non-market action's incentive compatibility binds (i.e., $\delta \leq \delta^u$). The key for the behavior of x^{nm} with respect to (ϕ, w, ξ) is how the punishment payoff varies relative to how the market return changes with them and how much they increase pledgable income. Because returns are concave and $y^{nm} < y^n$, improvements in (ϕ, w, ξ) increase more the market payoff than the payoff from the punishment phase. This together with the increase in pledgable income implies an increase in the non-market action. Because ψ increases the marginal return to the market action, the condition in the proposition ensures that the increase in the punishment payoff is more than compensated by the increase in the market payoff, which softens the non-market action's incentive constraint, and therefore the extra resources are spent in both actions so as to keep the marginal returns as close as possible.

Proposition 10. *If $w < w^{nmc}$, then x^{nm} is non-decreasing with (w, ξ, ψ) and non-increasing with ψ.*

When initial endowments are small, individuals' borrowing capacity is not enough to participate in both market and non-market exchange and they opt out of the market exchange. Because of this, they do not have access to borrowing and therefore their investment is independent of market-supporting institutions when the non-market action's incentive constraint does not bind. Otherwise, the non-market action falls with the improvements in market-supporting institutions since they increase the punishment payoff tightening the incentive constraint.

Because the equilibrium is symmetric, total welfare is $n + 1$ times the individual equilibrium payoff, denoted by V^{nm}, which is given by

$$\begin{cases} nf(\min\{x^{fb}, x^{nmu}(\delta)\}) + g(y^{mu}; \psi) + w - y^{mu} - \xi - \min\{x^{fb}, x^{nmu}(\delta)\} & \text{if } w \geq w^{nmu}, \\ nf(x^c(w + d^{nmc}, \delta)) + (1+\phi)^{-1}\phi\big(g(y^c(w + d^{nmc}, \delta); \psi) + w\big) & \text{if } w^{nmc} \leq w < w^{nmu}, \\ nf(\min\{w, x^{fb}, x(\delta, 0, 0)\}) + w - \min\{w, x^{fb}, x(\delta, 0, 0)\} & \text{if } w < w^{nmc}. \end{cases}$$

The next result deals with the comparative statics regarding welfare.

Proposition 11.

i) When $w \geq w^{nmu}$, V^{nm} increases with (w, ψ), is independent of ϕ, and decreases with ξ.

ii) When $w^{nmc} \leq w < w^{nmu}$, V^{nm} rises with (w, ψ) and falls with (ϕ, ξ).

iii) When $w < w^{nmc}$, V^{nm} rises with w and is independent of (ψ, ϕ, ξ).

As expected welfare is always increasing in the endowment, non-increasing in the fixed cost of using the market, and non-decreasing in the discount factor. With respect to market-supporting institutions (ϕ, ψ, ξ), welfare varies as expected; is non-increasing in (ϕ, ξ) and non-decreasing in

ψ. Thus, for any endowment $w \geq w^{nmc}$, improvements in market-supporting institutions result in larger welfare and w^{nmc} falls with ψ and increases with (ϕ, ξ).

6 The Relevance of Market-Supporting Institutions

6.1 Welfare Comparisons

The next proposition readily follow from comparing payoffs for both a purely non-market exchange and purely market exchange economy with those from an economy where both types of exchange are available.

Proposition 12.

i) If $w > w^{nmc}$, welfare in a market and non-market exchange economy is larger than that in a purely non-market exchange economy and in a purely market-exchange economy.

ii) If $w \leq w^{nmc}$, welfare in a market and non-market exchange economy is at best equal to that in a purely non-market exchange economy and at least as large as that in a purely market-exchange economy.

When individuals are rich, not only crowding out does not take place compared to a purely non-market exchange economy and to a purely market exchange economy, but individuals can also capitalize on the opportunities that each type of market exchange offers. Consequently, welfare in a market and non-market exchange economy exceeds that in a purely non-market exchange economy as well as that for a purely market-exchange economy.

For individuals who are neither rich nor poor, crowding out of non-market exchange relative to a purely non-market exchange economy and of market exchange relative to a purely market-exchange economy occurs as individuals are resource-constrained and allocate resources across market and non-market exchange to equalize their marginal returns, provided that the non-market action is incentive-compatible. Otherwise, they invest the incentive-compatible amount and allocate the surplus to the market action. In addition, due to the non-contractibility of the non-market action and return, when individuals invest in both types of exchange borrowing capacity suffers relative to a purely market-exchange economy. Despite the existence of partial crowding out and the decrease in borrowing capacity, welfare is higher in a market and non-market exchange economy than in a purely non-market exchange economy as well as in a purely market-exchange economy. The availability of market exchange allows individuals to leverage their returns, providing them with more resources to invest, as well as new and potentially more profitable investment opportunities. Similarly, having the possibility to invest in non-market exchange provides individuals, at the margin, with more profitable investment opportunities.

When individuals are poor, there is full crowding out of market exchange since they invest only in non-market exchange. Thus, individuals behave exactly as they would in a purely non-market exchange economy, but when $w \geq w^{mc}$, the existence of market exchange yields a higher payoff upon deviation, which is the payoff from market exchange. This means that the temptation to deviate is larger when market exchange is available and therefore the largest self-sustainable non-market action is smaller. When $w < w^{mc}$, the punishment upon deviation is autarky in both the purely non-market exchange economy and the market and non-market exchange economy, and therefore the largest self-sustainable non-market action is the same. Hence, when agents opt out of market exchange, they are worse off under a market and non-market exchange economy whenever $w \geq w^{mc}$ and the welfare-maximizing non-market action is not self-sustainable.

Hence, the introduction of anonymous formal markets in a purely non-market exchange economy results in partial crowding out and this is welfare-enhancing whenever $w \in [w^{nmc}, w^{nmu})$, since it allows for borrowing and enlarges the investment possibilities despite the fact that participating in market exchange is costly. In contrast, when $w < w^{nmc}$, welfare is lower due to the fact that the punishment payoff offered by market exchange is larger than or equal to the payoff from autarky. Because in this case market exchange is available in the same terms as in a purely market-exchange economy, welfare is larger in an economy when both exchanges are available. Otherwise, individuals would have choosen the purely market-exchange equilibrium.

6.2 The Development Process

This sub-section delves into the implications of investing in market-supporting institutions (ψ, ϕ, ξ) in terms of the development process.

An economy transitions from a purely non-market exchange economy to a modern economy where the coexistence of both market and non-market exchange is welfare-enhancing when its income exceeds the threshold w^{nmc}. However, this initial transition comes at the cost of crowding out non-market exchange relative to a purely non-market exchange economy and crowding out market exchange relative to a purely market-exchange economy. As income and market-supporting institutions improve, societies begin taking more advantage of both market and non-market exchange.

The thresholds w^{nmc} and w^{nmu} rise with (ϕ, ξ) and fall with ψ. Hence, improving market-supporting institutions facilitates the transition from a purely non-market exchange to a modern economy where both types of exchange are feasible, as well as the transition from a constrained efficient market and non-market exchange economy to an unconstrained one. Additionally, once this transition is complete, institutional improvements increase welfare, as shown in Propositions 11.

Because the establishment of robust market-supporting institutions typically necessitates substantial initial investments (fixed costs), it will be useful to consider the existence of a central planner with the ability to enhance the institutional settings (ψ, ϕ, ξ) at the outset of the repeated game, incurring costs composed of direct or indirect costs due to the need to raise funds (e.g., via taxes) to finance the institutional enhancement.

For all $w < w^{nmc}$, welfare satisfies the following: $V_{\xi}^{nm} = 0$, $V_{\psi}^{nm} = 0$, and $V_{\phi}^{nm} = 0$. Therefore, it is welfare-maximizing to refrain from investing in the improvement of market-supporting institutions. This decision maintains the threshold w^{nmc} unchanged, ensuring that, for all $w < w^{nmc}$, the constrained efficient economy will comprise only non-market exchange.

However, for $w \geq w^{nmc}$, welfare satisfies the following: $V_{\xi}^{nm} < 0$, $V_{\psi}^{nm} > 0$, and $V_{\phi}^{nm} < 0$. Thus, investing in market-supporting institutions becomes welfare-enhancing and reduces the thresholds w^{nmc} and w^{nmu}. If the initial endowment and market-supporting institutions are such that $w \geq w^{nmc}$ after the investments are undertaken, the state can enable a transition from a purely non-market exchange economy constrained by resources to a modern economy where both types of exchange are available. Importantly, the post-investment lower endowment thresholds due to the improvement in institutional quality not only allow modernization and unconstrained decisions but also enhance the economy's resilience to negative endowment shocks.

Therefore, the transition to a modern economy is made difficult by the fact that when individuals are poor, there are no incentives to make marginal institutional improvements. Escaping this equilibrium requires positive income shocks, a large scale so the economy is big enough to cover the fixed costs of creating and running high-quality market-supporting institutions, and significant institutional investments that put the economy on the track towards a modern and efficient economy (i.e., $w \geq w^{nmc}$), where improvements in market-supporting institutions become welfare-enhancing.

7 Discussion

Firstly, we could have assumed a different market equilibrium selection criteria that exacerbates crowing out instead of our chosen criteria which makes crowding out the least possible outcome. Namely, we could have selected the equilibrium in which individuals choose the market action that maximizes their individual payoff and, if after doing so, resources are not fully exhausted, individuals choose the non-market action that maximizes welfare subject to the incentive compatibility constraint. This implies to choose the minimum between the largest self-sustainable non-market action $x(\delta, y, m)$, the welfare-maximizing non-market action x^{fb}, and the remaining resources available.[30] This criteria provides the most adverse case for welfare-enhancing crowding out as well as complementarity between market and non-market exchange since the crowding out effect is the strongest. So, we can view this selection criterion as more resilient to community enforcement fail-

[30] All equilibrium selection criteria have weakness in some dimensions and are debatable, yet the chosen one is consistent with the individuals' behavior in the one-shot game.

ures, as individuals turn to non-market exchange only after exhausting the private benefits of formal enforcement.

One can show that most results holds under this criteria but in this case when individual are neither rich nor poor market exchange fully crowds out non-market exchange, while welfare maximization demands to participate in both non-market and market exchange. Hence, full crowding out is welfare decreasing when the endowment falls shorts of given threshold. Because market exchange enables borrowing, full crowding out is welfare enhancing when the endowment is such that individuals can borrow a large amount.

Secondly, the model does not allow for relationship lending. The mode can deal with it as long as debt maturity is one period. When relationship lending is possible and the worst possible punishment is to terminate it, it is possible to pledge to lenders the payoff to non-market exchange and therefore the incentive compatibility constraint becomes

$$nf(x(k)) + m(k)g(y(k);\psi) + d_i + w - r_i - x(k) - m(k)(y(k) + \xi) \geq \qquad (6)$$
$$(1-\delta)\phi\big(d_i + w\big) + \delta V^{nm}.$$

Once an individual chooses not to invest, the possibility of relationship lending is terminated forever thereafter and therefore the game switches to the equilibrium already derived, which does not consider relationship lending. Drawing a comparison between equations (5) and (6), it is easy to see that relationship lending increases the borrowing capacity whenever $nf(x(k)) \geq \delta\big(V^{nm} - \phi\big(d_i + w\big)\big)$.

Thirdly, the model assumes that non-market exchange involves everyone in the community. However, it is conceivable to assume either random matching or that the community's architecture is a network of complete components, where non-market exchange occurs within each component, while the entire community participates in market exchange.

Fourthly, the model assumes perfect information flows within the entire community. Introducing imperfect information flows would reduce the expected loss from reneging but wouldn't fundamentally alter our conclusions. However, adding incomplete information could significantly complicate the analysis, and the specifics would depend on assumptions about how information flows within the community. Namely, if we assume that with probability q everyone learns about a deviation and with probability $1-q$ no one learns, where q is interpret as the quality of community enforcement, we can easily show that for q sufficiently small, the welfare maximizing equilibrium may entail only market exchange when the endowment is sufficiently small so that individuals are resource constrained.

Fifthly, we have assumed that the choice of the market action does not entail strategic interactions among individuals. The model can easily accommodate them, without changing the main results, by assuming that $g(y;\psi)$, where $y \equiv (y_1, \ldots, y_{n+1})$.[31] In this case, the inefficiency in the choice of the market action would be different.

Sixthly, we have assumed identical individuals. This simplification was made to streamline the analysis. Introducing heterogeneity in various dimensions, such as initial endowments and different payoffs, could add realism. However, this would significantly complicate the algebra without necessarily enhancing economic intuition. While it could reflect a more realistic scenario with individuals participating in both market and none, others participating exclusively in either market or non-market exchange, the complexity introduced might outweigh the additional insights gained.

8 Conclusions

This paper argues that individuals, when impoverished, predominantly engage in non-market exchanges due to the marginal benefit of market participation being outweighed by fixed costs. Non-market exchanges, while enabling individuals to escape autarky, exclude them from capital markets due to the non-verifiability of payoffs. However, the fact that individuals upon deviating can engage in market exchange makes non-market exchange less efficient than in a purely non-market exchange economy.

For those who fall between poverty and affluence, participation in both market and non-market exchanges is observed. Resource constraints drive individuals to allocate resources to equalize marginal returns across these exchanges whenever the non-market exchange incentive compatibility constraint allows it. Otherwise, market exchange is restricted to the highest self-sustainable action and the rest is invested in market action. In this scenario, market and non-market exchanges become interconnected resulting in partial crowding out with respect to their corresponding purely exchange economy. In this case, market and non-market exchange become strategic complements in the sense that as market supporting institutions improve both increase when market-supporting institutions amplify market payoff more than the market action. This happens when creditors' protection is robust.

Affluent individuals choose to participate in both market and non-market exchanges, with the returns linked solely through incentive compatibility in non-market exchange. Rich and constrained individuals witness an increase in welfare as endowments rise and market-supporting institutions improve.

Consequently, partial crowding out of non-market exchange, relative to a purely non-market exchange economy, and crowding out of market exchange, relative to a purely market-exchange economy, occurs when individuals fall between poverty and affluence. Additionally, when this occurs is welfare-enhancing.

[31] An earlier version of this paper dealt with this case.

These results provide insights into the ongoing debate on whether the expansion of market exchange crowds out non-market exchange or enhances its benefits. The model posits that crowding out do take place but it is welfare-enhancing. This suggests a need to reframe the crowding out debate, emphasizing under what institutional settings it improves welfare and under which it may have adverse effects.

The predicted incentive complementarity and the underlying economic mechanism also offer crucial insights into a nation's development or stagnation. Improving market-supporting institutions requires significant investments, complicated further by the need for a minimum endowment level for both market and non-market exchange to be viable. Societies in poverty may become trapped in low-payoff purely non-market exchange economy, evolving to market exchanges as their endowment rises. Market-supporting institutions can help escape this cycle by increasing returns to market exchange, lowering market-use fixed costs, and increasing creditors' protection. Once a resource threshold is reached, complementarities come into play, necessitating investments in market-supporting institutions to fully exploit their potential complementarity.

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A Appendix

Proof of Proposition 3.

Lemma 1.

i) d^{mu} *is unique, increases with* (ψ, w)*, and decreases with* (ϕ, ξ)*.*

ii) There exists a unique endowment level, denoted by w^{mu}*, such that* $w + d^{mu} \leq y^{mu} + \xi$ *for all* $w \leq w^{mu}$*.* w^{mu} *rises with* (ϕ, ξ) *and falls with* ψ*.*

iii) There exists a unique endowment level, denoted by w^{mc}*, such that* $w + d^{mu} \leq \xi$ *for all* $w \leq w^{mc}$*.* w^{mc} *rises with* (ξ, ϕ) *and it is independent of* ψ*.*

Proof of Lemma 1. Observe that the largest incentive-compatible debt solves the following equation.

$$\begin{aligned} d = &\phi^{-1} m_i \big(g(\max\{0, \min\{w + d - \xi, y^{mu}\}; \psi) - \\ &\max\{0, \min\{w + d - \xi, y^{mu}\} - \xi \big) + (1 - \phi)\phi^{-1} w. \end{aligned} \tag{A1}$$

The LHS is increasing in d without bound and it is 0 at $d = 0$. When $m_i = 1$ and $w + d - \xi \leq y^{mu}$, the RHS is positive and increasing with d whenever $\phi^{-1}(g_i(y_i(k); \psi) - 1) \leq 0$, which holds because $w + d - \xi \leq y^{mu}$, while when $w + d - \xi \geq y^{mu}$ it is independent of d. Whenever the individual is credit constrained, it must be the case that $1 + \phi \geq g_i(y_i(d); \psi)$, otherwise he could increase its debt. It readily follows from this, continuity of the RHS of equation (A1), and the Intermediate Value Theorem that there is unique highest incentive compatible debt, denoted by d^{mu}.

Because $1 + \phi > g_i(y_i(d); \psi)$ whenever the credit constraint binds, d^{mu} increases with ψ since g rises with it and y_i is independent of it, decreases with ϕ since $(1 + \phi)^{-1}$ falls and $(1 + \phi)^{-1}$ rises with ϕ, increases with w whenever $g_i(y_i(d); \psi) - \phi > 0$, which is always the case because $\phi \leq 1$, and decreases with ξ whenever $g_i(y_i(d); \psi) > 1$.[32]

Next, observe that $w + d^{mu}$ increases with w since when unconstrained its slope is ϕ^{-1} and when constrained it its slope is given by

$$\frac{1}{1 + \phi - g_i(y_i(d); \psi)} > 0$$

where the inequality follows from the fact that the denominator is positive. This, together with Assumption 2, ensure that the existence of an endowment threshold, denoted by w^{mu}, such that the individuals are unconstrained whenever $w \geq w^{mu}$. Because $w + d^{mu} = y^{mu} + \xi$ at $w = w^{mu}$, it is

[32] Observe that a necessary condition for the credit constraint to bind is that $\phi < 2$.

easy to check that $w^{mu}_{\psi} = \big(y^{mu}_{\psi}(1+\phi-g_i)+g_{\psi}\big)|_{y^{mu}} > 0$ since $1+\phi-g_i>0$ and

$$w^{mu}_{\phi} = -\frac{1}{(1+\phi)^2}\frac{g+w}{1+\phi-g_i}\Big|_{y^{mu}} < 0.$$

Last observe that the fact that $w+d^{mu}$ increases with w, together with Assumption 2, ensure that the existence of an endowment threshold, denoted by w^{mc}, such that the individuals participate in the market whenever $w \geq w^{mu}$. Because $w+d^{mu}=\xi$ at $w=w^{mc}$. It is easy to check that $w^{mc}=\phi^{-1}\xi$ and thus it increases with ξ and falls with ψ. □

□

Proof of Proposition 5. If $w < w^{mu}$,

$$V^m_w = \frac{\phi}{1+\phi-g_i(y;\psi)}\Big|_{y=w+d^{mu}} > 0.$$

If $w \geq w^{mu}$, $V^m_{\psi} > 0$ if and only if

$$g_{\psi}g_{y_iy_i}(y^{mu};\psi) \leq 0,$$

while if $w < w^{mu}$,

$$V^m_{\psi} = \frac{\phi g_{\psi}}{1+\phi-g_i(y;\psi)}\Big|_{y=w+d^{mu}} > 0.$$

If $w \geq w^{mu}$, $V^m_{\phi}=0$, while if $w<w^{mu}$,

$$V^m_{\phi} = -\frac{(g_i-1)(w+d^{mc})}{1+\phi-g_i(y;\psi)}\Big|_{y=w+d^{mu}} < 0,$$

since $1+\phi-g_i(y^m;\psi)>0$. If $w \geq w^{mu}$, $V^m_{\xi}=-1$, while if $w<w^{mu}$,

$$V^m_{\xi} = -\frac{\phi g_i}{1+\phi-g_i(y;\psi)}\Big|_{y=w+d^{mu}} < 0,$$

since $1+\phi-g_i(y^m;\psi)>0$. □

Proof of Proposition 6.

Lemma 2. *There exists threshold $\delta^c(k)$ such that $(x_i(k),y_i(k))=(x^c_i(k),y^c_i(k))$ for all $\delta>\delta^c(k)$ and $(x_i(k),y_i(k))=(x_i(k,\delta),y_i(k,\delta)$ for all $\delta\leq\delta^c(k)$. $\delta^c(k)$ rises with k.*

Proof of Lemma 2. Recall the first-order conditions

$$x_i : \sum_{j \neq i} f_i(x_i) - 1 - \lambda_i + \mu_i(\delta \sum_{j \neq i} f_i(x_i) - 1) = 0,$$
$$y_i : g_i(y_i; \psi) - 1 - \lambda_i + \mu_i \delta(g_i(y_i; \psi) - 1).$$

where $\lambda_i \geq 0$ is the Lagrange multiplier for individual i's resource constraint and $\mu_i \geq 0$ is the Lagrange multiplier for individual i's incentive compatibility constraint.

From the resource constraint, we get that $\lambda_i = (\mu_i \delta + 1)(g(y_i; \psi) - 1) \geq 0$ and substituting this into the first-order condition for x_i, we deduce that

$$\mu_i = \frac{\sum_{j \neq i} f_i(x_i) - g_i(y_i; \psi)}{\delta(g_i(y_i; \psi) - \sum_{j \neq i} f_i(x_i)) + 1 - \delta}.$$

Hence, if $k_i < k^u(\delta)$, $m_i = 1$, and $\mu_i = 0$, $\sum_{j \neq i} f_i(x_i) - g_i(y_i; \psi)$ and $k_i = x_i + y_i + \xi$, while if $\mu_i > 0$, then $x_i = x_i(k, \delta)$ and $y_i(k, \delta) = k_i - x_i(k, \delta) - \xi$, where $x_i(k, \delta)$ is the largest solution to

$$x_i = \delta\Big(nf(x_i) + g(k_i - x_i - \xi; \psi) - r_i + x_i - V_i(\phi, \psi, w, \xi)\Big).$$

Let's denote the solution in the first case by $(x_i^c(k), y_i^c(k))$ and in the second one by $(x_i(k, \delta), y_i(k, \delta))$.

Observe that $x_i(k, \delta)$ is the solution to

$$x_i = \delta\Big(nf(x_i) + g(k_i - x_i - \xi; \psi) - r_i + x_i - V^m\Big).$$

and therefore

$$\frac{\partial x_i(k, \delta)}{\partial \delta} = \frac{nf(x_i) + g(k_i - x_i - \xi; \psi) - r_i + x_i - V^m}{\delta(g_i(y_i; \psi) - \sum_{j \neq i} f_i(x_i)) + 1 - \delta} > 0.$$

Because $x_i^c(k)$ is independent of δ and $x_i^c(k) < x^{fb}$ since $g_i(y_i; \psi) > 1$ for all $y_i < y^{mu}$, there exists a threshold $\delta^c(k)$ such that $x_i^c(k) < x_i(k, \delta)$ for all $\delta > \delta^c(k)$. Because

$$\frac{\partial x_i^c(k)}{\partial k_i} = \frac{g_{ii}}{nf_{ii} + g_{ii}} \in (0, 1)$$

and

$$\frac{\partial x_i(k, \delta)}{\partial k_i} = \frac{\delta(g_i(y_i; \psi) - V_w^m)}{\delta(g_i(y_i; \psi) - \sum_{j \neq i} f_i(x_i)) + 1 - \delta} > 0,$$

$\delta^c(k)$ rises with k.

□

Lemma 3. *There exists a threshold k, denoted by $k^c(\delta)$, such that it is welfare maximizing to opt out of market exchange whenever $k \leq k^c(\delta)$.*

Proof of Lemma 3. Observe that if individuals opt out of the market, welfare is given by

$$nf(\min\{k, x^{fb}, x(\delta,0,0)\}) + k - \min\{k, x^{fb}, x(\delta,0,0)\},$$

where $x(\delta, 0, 0)$ is the largest solution to $x_i = \delta\Big(f(x_j) + k_i - r_i - V^m\Big)$, while if they choose to participate in both market and non-market exchange, welfare is given by $nf(x_j(k)) + g(y_i(k);\psi) - d$, where $(x_i(k), y_i(k)) = (x_i^c(k), y_i^c(k))$ for all $\delta > \delta^c(k)$ and $(x_i(k), y_i(k)) = (x_i(k,\delta), y_i(k,\delta)$ for all $\delta \leq \delta^c(k)$. Thus, it is optimal to opt out of market exchange iff

$$nf(\min\{k, x^{fb}, x(\delta,0,0)\}) + k - \min\{k, x^{fb}, x(\delta,0,0)\} > nf(x_i(k)) + g(y_i(k);\psi) + w - k.$$

First notice that at $k = \xi$, this inequality holds since the RHS is zero, while the LHS is positive, while at $k = k^u(\delta)$, the opposite holds since it is feasible to implement $(\min\{x^{fb}, x^{nmu}(\delta), y^{mu})$.

Observe that the LHS rises monotonically with k since

$$(nf_i(\min\{k, x^{fb}, x(\delta,0,0)\}) - 1)\frac{\partial \min\{k, x^{fb}, x(\delta,0,0)\}}{\partial k} + 1 > 1.$$

The RHS rises k since

$$(nf_i(x_i(k)) - g_i(y_i(k);\psi))\frac{\partial x_i(k)}{\partial k} + g_i(y_i(k);\psi) > 1,$$

where $y_i(k) = k - x_i(k) - \xi$, $g_i(y_i(k);\psi) > 1$, and

$$\frac{\partial x_i^c(k)}{\partial k_i} = \frac{g_{ii}}{nf_{ii} + g_{ii}} \in (0,1)$$

and

$$\frac{\partial x_i(k,\delta)}{\partial k_i} = \frac{\delta(g_i(y_i;\psi) - V_w^m)}{\delta(g_i(y_i;\psi) - \sum_{j\neq i} f_i(x_i)) + 1 - \delta} > 0.$$

It follows from this and the Intermediate Value Theorem that there exists a k, denoted by $k^c(\delta) > \xi$ such that it is welfare maximizing to step out of the market whenever $k \leq k^c(\delta)$. □

The proposition readily follows from these two lemmas. □

Proof of Proposition 7.

Lemma 4.

i) There exits a unique endowment level, denoted by w^{nmu}, such that the incentive-compatible debt is greater than or equal to d^{nmu}. w^{nmu} increases with $(\phi, \psi, \xi, \delta)$.

ii) d^{nmc} decreases with (ϕ, ξ), increases with ψ, and increases with w whenever $g_i(y^c(k, \delta); \psi)\frac{\partial y^c(k,\delta)}{\partial w} > \phi$.

iii) There exists a unique endowment level, denoted by w^{nmc}, such that

$$nf(\min\{w, x^{fb}, x(\delta, 0, 0)\}) + w - \min\{w, x^{fb}, x(\delta, 0, 0)\} =$$
$$nf(x^c(w + d^{nmc}, \delta)) + g(y^c(w + d^{nmc}, \delta); \psi) - d^{nmc}.$$

iv) w^{nmc} rises with (ϕ, ξ) and decreases with ψ.

Proof of Lemma 4. w^{nmu} must solve the following

$$\min\{x^{fb}, x^{nmu}(\delta)\} + y^{mu} - w =$$
$$\phi^{-1}\big(g(y^{mu}; \psi) - y^{mu} - \xi + (1 - \phi)w - \min\{x^{fb}, x^{nmu}(\delta)\}\big). \tag{A2}$$

If $\delta \geq \delta^u$, this becomes

$$w = (1 + \phi)(x^{fb} + y^{mu}) - g(y^{mu}; \psi) + \xi.$$

and thereby w exists and its unique since the RHS independent of w and it is positive due to Assumption 2.

If $\delta < \delta^u$, then

$$w = (1 + \phi)(x^{nmu}(\delta) + y^{mu} + \xi) - g(y^{mu}; \psi).$$

The LHS rises with w without bound and it is zero at $w = 0$, while the RHS it is positive and falls whenever $(nf_i(x^{nmu}(\delta)) - 1 - \phi)\frac{\partial x^{nmu}(\delta)}{\partial w} \leq 0$, where

$$\frac{\partial x^{nmu}(\delta)}{\partial w} = \frac{1 - V_w^m}{1 - \delta nf_i(x_i)}\Big|_{x = x^{nmu}(\delta)} \leq 0$$

where the inequality follows from Proposition 5, where it is shown that $V_w^m \leq 1$. and $1 - \delta nf_i(x_i)) < 0$, otherwise a higher non-market action will be incentive compatible. Observe that $nf_i(x^{nmu}(\delta)) - 1 - \phi < 0$, otherwise by increasing x, individuals will be able to borrow more and thereby they would not be constrained. Hence, by the Intermediate Value Theorem there exits a unique w that solves this equation.

Next, let's consider the case in which $w < w^{nmu}$. In this case, the totality of resources are spent in exchange. Let's denote the highest incentive compatible debt by d^{nmc}. Then, for $m = 1$, there are two cases to consider: $(x^c(k,\delta), y^c(k,\delta)) = (x^c(k), y^c(k))$ for all $\delta > \delta^c(k)$ and $(x(k), y(k)) = (x(k,\delta), y(k,\delta)$ for all $\delta \leq \delta^c(k)$.

Recall that the highest incentive compatible debt is

$$d = \frac{1}{1+\phi}\big(g(y^c(k,\delta);\psi) - \phi w\big).$$

Observe that the LHS increases without bound for all d and it is zero at $d = 0$. For $m_i = 1$, the RHS is positive for all d and rises with d whenever

$$\frac{1}{1+\phi}\Big(1 - \frac{\partial x_i(k)}{\partial d}\Big) g_i(y_i(k);\psi) > 0, \tag{A3}$$

where $y_i(k) = k - x_i(k) - \xi$, $g_i(y_i(k);\psi) > 1$, and for all $\delta > \delta^c(k)$, $\frac{\partial y^c(k,\delta)}{\partial d}$ is given by

$$\frac{\partial x_i^c(k)}{\partial d} = \frac{g_{ii}}{nf_{ii} + g_{ii}} \in (0,1)$$

and for all $\delta \leq \delta^c(k)$, it is given by

$$\frac{\partial x_i(k,\delta)}{\partial d} = \frac{\delta(g_i(y_i;\psi) - V_w^m)}{\delta(g_i(y_i;\psi) - nf_i(x_i)) + 1 - \delta} \in (0,1),$$

since $1 - \delta + \delta(V_w^m - nf_i(x_i)) \geq 0$ for all δ.

Observe that the LHS increases at higher rate than the LHS whenever

$$\Big(1 - \frac{\partial x_i(k)}{\partial d}\Big) g_i(y_i(k);\psi) < 1 + \phi, \tag{A4}$$

which holds whenever the individual is constrained since $g_i(y_i(k);\psi) < 1 + \phi$, otherwise he could increase debt.

It readily follows from this and the Intermediate Value Theorem that there is unique highest incentive compatible debt, denoted by d^{nmc}.

It is easy to check that

$$\Big(1 + \phi - \frac{\partial y^c(k,\delta)}{\partial d} g_i(y^c(k,\delta);\psi)\Big)\frac{\partial d^{nmc}}{\partial z} =$$
$$g_i(y^c(k,\delta);\psi)\frac{\partial y^c(k,\delta)}{\partial z} + g_z(y^c(k,\delta);\psi) - \phi I(w) - (d^{nmc} + w)I(\phi),$$

where $I(w) = 1$ for $z = w$ and $I(w) = 0$ for $z \neq w$ and $I(\phi) = 1$ for $z = \phi$ and $I(\phi) = 0$ for $z \neq \phi$.

For $z = \xi$, the RHS is negative since $y_i(k)$ falls with ξ. For $z = \phi$, the RHS is negative since $y_i(k)$ is independent of ϕ. For $z = \psi$, the RHS is positive since $y_i(k)$ rises with ψ and $g^i_\psi(y^c(k,\delta);\psi) > 0$. For $z = \delta$, the RHS is non-positive since $y_i(k)$ is non increasing with δ. Hence, d^{nmc} falls with (ϕ, ξ), rises with ξ, and is non-increasing with δ.

For $z = w$, the RHS is positive whenever

$$g_i(y^c(k,\delta);\psi)\frac{\partial y^c(k,\delta)}{\partial z} \geq \phi,$$

where

$$\frac{\partial y_i^c(k)}{\partial k_i} = \frac{nf_{ii}}{nf_{ii} + g_{ii}} \in (0,1)$$

and

$$\frac{\partial y_i(k,\delta)}{\partial k_i} = \frac{1 - \delta - \delta(nf_i(x_i) - V_w^m)}{\delta(g_i(y_i;\psi) - nf_i(x_i)) + 1 - \delta} \in (0,1).$$

Next, observe that $w + d^{nmc}$ increases with w since it its slope is given by

$$\frac{1}{1 + \phi - \frac{\partial y^c(k,\delta)}{\partial d} g_i(y^c(k,\delta);\psi)} > 0,$$

where the inequality follows from the fact that the denominator is positive.

This, together with Assumption 2, ensure that the existence of an endowment threshold, denoted by w^{nmc}, such that

$$\begin{aligned} &nf(\min\{w, x^{fb}, x(\delta,0,0)\}) + w - \min\{w, x^{fb}, x(\delta,0,0)\} = \\ &nf(x^c(w + d^{nmc},\delta)) + g(y^c(w + d^{nmc},\delta);\psi) - d^{nmc}. \end{aligned}$$

To see this, firstly, observe that $w = \xi$, the LHS is positive, while the RHS is zero since $w + d^{nmc} = \xi$ and $x^c(w + d^{nmc};\delta) = y^c(w + d^{nmc};\delta) = 0$, while when w is such that $w + d^{nmc} = \min\{x^{fb}, x^{nmu}(\delta)\} + y^{mu}$, the RHS is higher than the LHS, since $x^c(w + d^{nmc},\delta) = \min\{x^{fb}, x^{nmu}(\delta)\}$ and $y^c(w + d^{nmc},\delta) = y^{mu}$.

Secondly, the LHS rises monotonically with w since

$$(nf_i(\min\{w, x^{fb}, x(\delta,0,0)\}) - 1)\frac{\partial \min\{w, x^{fb}, x(\delta,0,0)\}}{\partial w} + 1 > 1.$$

When $x^c(w + d^{nmc};\delta) = x^c(w + d^{nmc})$, the RHS rises w since

$$g_i(y^c(w + d^{nmc},\delta);\psi)\frac{\partial(w + d^{nmc})}{\partial w} - \frac{\partial d^{nmc}}{\partial w} > 1$$

where $y^c(w+d^{nmc},\delta) = w + d^{nmc} - x^c(w+d^{nmc}) - \xi$, $g_i(w+d^{nmc};\psi) > 1$, and

$$\frac{\partial x_i^c(k)}{\partial w} = \frac{g_{ii}}{nf_{ii} + g_{ii}} \in (0,1).$$

When $x^c(w+d^{nmc};\delta) = x_i(w+d^{nmc},\delta)$, the RHS rises w since

$$(nf_i(x^c(w+d^{nmc},\delta)) - g_i(y^c(w+d^{nmc},\delta);\psi))\frac{\partial x(w+d^{nmc},\delta)}{\partial w} + \\ g_i(y^c(w+d^{nmc},\delta);\psi)\frac{\partial(w+d^{nmc})}{\partial w} - \frac{\partial d^{nmc}}{\partial w} > 1$$

and $nf_i(x^c(w+d^{nmc},\delta)) - g_i(y^c(w+d^{nmc},\delta);\psi) > 0$, where

$$\frac{\partial x_i(k,\delta)}{\partial w} = \frac{\delta(g_i(y_i;\psi) - V_w^m)}{\delta(g_i(y_i;\psi) - nf_i(x_i)) + 1 - \delta} > 0.$$

Observe that $x(\delta,0,0)$ is the highest non-market action that solves

$$x_i = \delta\Big(nf(x_i) + w - V^m\Big).$$

and

$$\frac{\partial x(\delta,0,0)}{\partial w} = \frac{\delta(1-V_w^m)}{1-\delta nf_i(x)} \geq 0,$$

where $V_w < 1$ for all $w < w^{mu}$ and $V_w^m = 1$ for all $w \geq w^{mu}$, where $w^{mu} < w^{nmu}$, while $x(\delta, y^c(w+d^{nmc},\delta), 1)$ is the highest non-market action that solves

$$x_i \leq \delta\Big(nf(x_j) + g(y^c(w+d^{nmc},\delta);\psi) + w - y^c(w+d^{nmc},\delta) - \xi - V^m\Big).$$

It readily follows from this that there exists a endowment threshold $\hat{w}$ such that

$$x(\delta, y^c(w+d^{nmc},\delta), 1) > x(\delta,0,0),$$

since $g(y^c(w+d^{nmc},\delta);\psi) + w - y^c(w+d^{nmc},\delta) - \xi > w$ for all $w \geq \hat{w}$.

We deduce from the preceeding discussion and the Intermediate Value Theorem that there exists a w, denoted by $w^{nmc} > \xi$ such that it is welfare maximizing to step out of the market whenever $w \leq w^{nmc}$.

□

We deduce the proposition from this Lemma and Proposition 6. □

Proof of Proposition 8. First, $w \geq w^{nmu}$ and $\delta \geq \delta^u$. Then, $x_z^{nm} = x_z^{fb}$ and $y_z^{nm} = y_z^{mu}$, where $d^{nm}(\psi,w) = y^{mu} + x^{fb} - w$. Hence, $x_z^{nm} = 0$ for any $z \in \{\psi,\phi,w\}$ and $y_\phi^{nm} = 0$, $y_w^{nm} = 0$, and

$y_\psi^{nm} > 0$ if and only if $g(y^{mu};\psi) - y^{mu}$ rises with ψ. This entails the following

$$\Big(g_\psi(y_i;\psi) - \frac{g_{i\psi}(y_i;\psi)}{\sum_j g_{ii}(y_i;\psi)} g_i(y_i;\psi)\Big)\Big|_{y^{mu}} \geq \frac{(1+\phi)g_\psi(y);\psi)}{1+\phi - g_i(y_i;\psi)}\Big|_{y(d^{se})}.$$

Next, let's assume that $w \geq w^{nmu}$ and $\delta < \delta^u$. Hence, $y_\psi^{nm} > 0$ if and only if $g(y^{mu};\psi) - y^{mu}$ rises with ψ, and $y_\phi^{nm} = y_w^{nm} = 0$. In this case, $x_z^{nm} = x^{nmu}(\delta)$. Because $w^{nmu} > w^{mu}$, $g(y^{mu};\psi) - y^{mu} - V = 0$. It readily follows form this that $x_w^{nm} > 0$, and $x_\psi^{nm} = x_\phi^{nm} = 0$. □

Proof of Proposition 9. First, recall that w^{nmc} solves

$$w + d^{nmc} = \frac{1}{1+\phi}\big(g(y^{nmc};\psi) + w\big).$$

. Thus,

$$\big(1+\phi\big)\frac{\partial(w + d^{nmc} - \xi)}{\partial z} = g_\psi + g_i y_z^{nmc} + I(w) - (w + d^{nmc} - \xi)I(\phi) - (1+\phi)I(\xi), \quad \text{(A5)}$$

where $I(x) = 1$ when $z = x$ and $I(x) = 0$ otherwise.

When $\delta \geq \delta^c(w + d^{nmc})$, the incentive constraint regarding x is non binding and therefore where $y^{nmc} = w + d^{nmc} - \xi - x^{nmc}$ and $g_i(y;\psi) - f_i(w + d^{nmc} - \xi - y) = 0$. Thus,

$$y_z^{nmc}(g_{ii} + nf_{ii}) + g_{i\psi}I(\psi) - nf_{ii}\frac{\partial(w + d^{nmc} - \xi)}{\partial z} = 0.$$

Solving for y_z^{nmc} and $\frac{\partial(w+d^{nmc}-\xi)}{\partial z}$, one gets after some algebra that

$$\frac{\partial(w + d^{nmc} - \xi)}{\partial z} = \frac{-g_i g_{i\psi} + (I(w) - (w + d^{nmc} - \xi)I(\phi) - \xi I(\phi) - (1+\phi)I(\xi) + g_z)(g_{ii} + nf_{ii})}{(1+\phi)(g_{ii} + nf_{ii}) - g_i f_{ii}} \quad \text{(A6)}$$

and

$$y_z^{nmc} = \frac{(1+\phi)g_{i\psi} + (I(w) - (w + d^{nmc} - \xi)I(\phi) - \xi I(\phi) - (1+\phi)I(\xi) + g_z)nf_{ii}}{(1+\phi)(g_{ii} + nf_{ii}) - g_i f_{ii}},$$

where $I(w) = 1$ if $z = w$ and $I(w) = 0$ otherwise, $I(\phi) = 1$ if $z = \phi$ and $I(\phi) = 0$ otherwise, and $I(\xi) = 1$ if $z = \xi$ and $I(\xi) = 0$ otherwise.

Because the denominator is negative, y^{nmc} falls with (ξ, ϕ), rises with w, and rises with ψ whenever $(1+\phi)g_{i\psi} \geq nf_{ii}g_\psi$, which holds since $f_{ii} < 0$.

Because

$$\begin{aligned}
x_z^{nm} =& \frac{\partial(w+d^{nmc}-\xi)}{\partial z} - y_z^{nm} \\
=& \Big(\frac{\partial(w+d^{nmc}-\xi)}{\partial z} g_{ii} + g_{i\psi}\Big)\frac{1}{g_{ii}+nf_{ii}} \\
=& \frac{g_{i\psi}(1+\phi-g_i) + (I(w) - (w+d^{nmc}-\xi)I(\phi) - \xi I(\phi) - (1+\phi)I(\xi) + g_z)g_{ii}}{(1+\phi)(g_{ii}+nf_{ii}) - g_i f_{ii}}.
\end{aligned}$$

One can check after some simples algebra that x^{nm} falls with (ξ, ϕ), rises with w, and rises with ψ whenever

$$g_{ii}g_\psi + g_{i\psi}(1+\phi-g_i) \le 0$$

When $\delta < \delta^c(w+d^{nmc})$, x^{nmc} is the solution to the incentive constraint and $y^{nmc} = w + d^{nmc} - \xi - x^{nmc}$. Thus,

$$x_z^{nmc}(1-\delta-\delta(nf_i-g_i)) = \delta\Big(g_\psi + (g_i-1)\frac{\partial(w+d^{nmc}-\xi)}{\partial z} + I(w) - I(\xi) - V_z^m\Big).$$

Solving for x_z^{nmc} and $\frac{\partial(w+d^{nmc}-\xi)}{\partial z}$, one gets that

$$x_z^{nmc} = \delta\frac{(g_\psi + I(w) - I(\xi))\phi - (g_i-1)((w+d^{nmc}-\xi)I(\phi) + \phi I(\xi)) - V_z^m(1+\phi-g_i)}{(1-\delta-\delta(nf_i-g_i))(1+\phi) - g_i(1-\delta nf_i)}.$$

Because the denominator is positive and $g_i > 1$, $y^{nm} < y^m$, and g_i is decreasing, it easy to see that x_z^{nmc} falls with ϕ since $(g_i-1)(w+d^{nmc}) - V_\phi^m(1+\phi-g_i) > 0$, drops with ξ since $\phi g_i - V_\xi^m(1+\phi-g_i)$, rises with w since $V_w^m \le 1$, and rises with ψ if and only if $\frac{\phi g_\psi}{1+\phi-g_i} - V_\psi^m > 0$. Observe that $\frac{\phi g_\psi}{1+\phi-g_i}$ falls with y whenever $g_{ii}g_\psi + g_{i\psi}(1+\phi-g_i) \le 0$. Because $y^{nm} < y^m$, the inequality holds whenever this holds.

$$\begin{aligned}
y_z^{nmc} =& \frac{1}{(1-\delta-\delta(nf_i-g_i))(1+\phi) - g_i(1-\delta nf_i)} \times \\
& \Big(((g_\psi + I(w) - (1+\phi)I(\xi) - (w+d^{nmc}-\xi)I(\phi))(1-\delta nf_i) - \\
& \delta(1+\phi)(g_\psi - V_\psi^m + I(w) - I(\xi)) + \delta(g_i-1)((w+d^{nmc}-\xi)I(\phi) + \phi I(\xi))\Big).
\end{aligned}$$

Because the denominator is positive, it easy to see that y_z^{nmc} falls with (ϕ, ξ), rises with w, and rises with ψ if and only if $g_\psi(1-\delta nf_i) - (1+\phi)\delta(g_\psi - V_\psi^m) \ge 0$. This follows from substituting for V_ψ^m into this equation since $g_{i\psi} > 0$, $V_\psi^m = g_\psi(y^{mu};\psi)$ if $w \ge w^{mu}$ and

$$V_\psi^m = \frac{\phi g_\psi}{1+\phi-g_i(y;\psi)}\Big|_{y=w+d^{mu}} > 0.$$

otherwise.

□

Proof of Proposition 11. If $\delta \geq \delta^u$, this is increasing if and only if

$$\left(g_\psi - g_i \frac{g_{i\psi}}{g_{ii}}\right)\Big|_{y^{mu}} > 0,$$

while if $\delta < \delta^u$, $V(\phi, \psi, w, \delta)$ rises with ψ if and only if

$$\left((nf_i - 1)x_\psi^{nm} + g_\psi\right)\Big|_{(x^{nmu}(\delta), y^{mu})} > 0,$$

where the inequality follows from the fact that $nf_i - 1 > 0$ and $x_\psi^{nm} \geq 0$.

Because $\min\{x^{fb}, x^{nmu}(\delta)\} - (1-\phi)\sum_{j\neq i} f(\min\{x^{fb}, x^{nmu}(\delta)\}) \geq 0$, $w^{nmu} \geq w^{mu}$, welfare increases with ψ if and only if $V_\psi > 0$ and and raises with w if and only if

$$\left(1 - \delta n f_{x_i}(x))V_w^m\right)\Big|_{(x^{nmu}(\delta), y^{mu})} > 0.$$

where the inequality follows from the that the incentive-compatibility constrain binds and therefore $1 - \delta n f_{x_i}(x) > 0$

If $w^{nmc} \leq w < w^{nmu}$, V_z^m is given by

$$nf_i\Big(\frac{w + d^{nmc}}{\partial z} - y_z^{nm}\Big) + g_i y_z^{nm} + g_z + \phi(1+\phi)^{-1}I(w) + (1+\phi)^{-1}(g + w)I(\phi) - nf_i I(\xi)$$

Substituting into for $\frac{\partial(w+d^{nmc})}{\partial z}$ from equation (A6), this becomes

$$nf_i\Big(\frac{g_z + g_i y_z^{nm} + I(w) - (w + d^{nmc})I(\phi)}{1 + \phi - g_i y_k^{nm}} - y_z^{nm}\Big) + g_i y_z^{nm} + g_z +$$
$$\phi(1+\phi)^{-1}I(w) + (1+\phi)^{-1}(g + w)I(\phi) - nf_i I(\xi)$$

For $z \in (\phi, w, \xi, \delta)$, the result readily follows from this after a few steps of simple algebra. For $z = \psi$, this becomes

$$nf_i\Big(\frac{g_z + y_z^{nm}(g_i(1 + y_k^{nm}) - 1 - \phi)}{1 + \phi - g_i y_k^{nm}}\Big) + g_i y_z^{nm} + g_z.$$

When $x^{nm} = x^c(w + d^{nmc})$, this is positive since $g_i = nf_i$ and $1 + \phi - g_i y_k^{nm} > 0$. When $x^{nm} = x(w + d^{nmc}; \delta)$, $g_i < nf_i$ and the result follows from substituting into this for

$$y_z^{nm}\big((1 + \phi - g_i y_k^{nm})(1 - \delta - \delta(nf_i - g_i) - (1 - \delta - \delta n f_i)g_i\big) =$$
$$(1 - \delta - \delta n f_i)(g_z + I(w) - (w + d^{nmc})I(\phi) - I(\xi)) - \delta(g_z^i - V_z^m))(1 + \phi - g_i y_k^{nm}),$$

one can show that

$$
\begin{aligned}
& nf_i\Big(\frac{g_z + y_z^{nm}(g_i(1+y_k^{nm}) - 1 - \phi)}{1+\phi - g_i y_k^{nm}}\Big) + g_i y_z^{nm} + g_z \\
=& \frac{(1+\phi - g_i y_k^{nm})^2(1-\delta) + \delta V_z^m(1+\phi - g_i y_k^{nm})}{(1+\phi - g_i y_k^{nm})(1-\delta-\delta(nf_i - g_i) - (1-\delta-\delta nf_i)g_i} \\
>& 0,
\end{aligned}
$$

where the inequality follows from the fact that $V_\psi^m \geq 0$ and $1+\phi-g_iy_k^{nm} > 0$. The last part is straightforward.

Lastly, let's consider the case in which $w < w^{nmc}$. In this case, $x(\delta, 0, 0)$ is non-increasing with (w, ψ) and non-decreasing with (ξ, ϕ) since the payoff from the one static game V rises with (ψ, w) and falls with (ϕ, ξ). Hence whenever $w^{nmc} > w \geq w^{mc}$, the payoff during the punishment phase is V^m. When $w < w^{mc}$, the equilibrium in the static game entails autarky and thereby the payoff during the punishment phase is w. □