Market and Non-Market Exchange and Market-Supporting Institutions

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June 10, 2024

Abstract

Does market exchange reduce participation in non-market exchange thus reducing overall welfare? Some have argued that markets strengthen the conditions for a vibrant non-market exchange. Others contend that markets crowd out non-market exchange by promoting individualism, alienating individuals, and displacing social ties. This paper argues that having access to market and non-market exchange is welfare-enhancing despite any crowding out that may occur when individuals are not too impatient and endowments are not too small. Furthermore, improvements in the quality of market-supporting institutions increase welfare and help mitigate the costs of crowding out. Thus, an efficient economy with a combination of market and non-market exchange is crucial for achieving higher well-being compared to a purely non-market exchange economy and a purely 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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†Thanks the financial support of The Nucleus Labor Market Mismatch: Causes and Consequences, grant NCS 2022-045, the Institute for Engineering Complex Systems, grants ICM P05-004F and Institute for Research in Market Imperfections and Public Policy, MIPP, grant ICM IS130002.

> "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 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, Montesquieu, and Condorcet have argued that markets reinforce durable and peaceful relations that 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]

This paper focuses on the coexistence and interaction between market and non-market exchanges when the participation choice is endogenous and payoffs are independent of each other. We explore a mechanism that links the two types of exchange with market-supporting institutions and investigate the welfare effects of this mechanism. The paper's main argument is that when market institutions are efficient, market investment opportunities provide individuals with 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.

Consider a setting in which people repeatedly choose to participate in both market and non- market

[1]Non-market exchange refers to the exchange of goods and services outside the market. This can include bartering, gift-giving, and sharing economy transactions. These types of exchanges are often based on social relationships. 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.

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

[3]See, Besley (2013) for 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 based on which the market itself is working and, thereby, result in self-destruction.

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

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 paying a fixed cost. On the other hand, non-market exchanges are governed by community actions and 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 and the payoff to market exchange depends 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 directly affect the payoff of non-market exchange but they could do it indirectly as they alter the payoff to deviation in non-market exchange. Furthermore, individuals who renege in non-market exchange can continue their activity in the market without punishment, which insulates the market-exchange payoff from non-market activity.

How do market-supporting institutions then affect non-market exchange? In a purely non-market exchange economy, individuals play grim trigger strategies and choose between the largest self-sustainable non-market expenditure and the welfare-maximizing market expenditure 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 provides an investment and a consumption opportunity, and market institutions are adequately efficient, individuals have a powerful incentive to cooperate 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 than that when market exchange is possible and because the market expenditure diverts resources towards it and against non-market expenditure.

When looking at initial endowments, interesting parameter regions arise. There are two thresholds; a low and a high threshold. When the initial endowment is higher than the upper one (the wealthy income case), individuals participate in both market investment and consumption and in non-market exchange. There is no crowding out because the resource constraint does not bind and incentives to participate, at a given intensity, in non-market exchange are not harmed by the possibility to engage in market exchange after reneging. This is not particularly revealing because the interaction between the two exchanges is not constrained and strategic interaction between them does not arise. This happens even when the non-market exchange incentive compatibility constraint binds.

[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 dependent on other actors' actions as in non-competitive markets.

[7] To keep the analysis as simple as possible, we do not allow for savings. Hence, each period is identical to the preceding one and thereby we keep the model within the realm of repeated games.

When the initial endowment is lower than the lower threshold (the lower income case), individuals only engage in market consumption but not in market investment. In terms of welfare, individuals are better off than in a purely market exchange economy, since non-market exchange provides an expenditure alternative to market consumption. However, they are worse off than in a non-market exchange economy when the incentive constraint binds because this limits the non-market expenditure since the existence of markets lessens the punishment power of trigger strategies. For a low endowment level, the non-market utility loss from a tightened incentive constraint cannot be compensated by the utility gain from market consumption.

When the initial endowment falls between the two thresholds (the middle-income case), individuals participate in both exchanges and crowding out occurs.[8] First, a sufficient endowment makes participation in the market investment profitable as individuals are wealthy enough to pay the fixed cost of doing so and to benefit from the market investment; that is, the endowment plus the return minus the fixed cost exceeds the endowment. At the margin, market exchange offers a consumption opportunity that crowds out non-market exchange. However, this crowding out is welfare-improving because it allows for substitution towards consumption with a higher marginal utility at the margin.

Thus, introducing market exchange into a purely non-market exchange economy is welfare enhancing when individuals can take advantage of the market investment because this results in larger income that allows them to compensate for the non-market utility loss created by the fact that market consumption makes the punishment from reneging small and therefore decreases the non-market self-sustainable expenditure. Thus, despite the independence between the payoffs from non-market and market exchange, they become linked through both the incentive-compatibility constraint regarding non-market exchange and the income constraint when, in any equilibrium, individuals are impatient and income-constraint. This is a key mechanism in the paper, market exchange creates extra income that can be spent on market and non-market consumption, and as market institutions improve, market investment becomes more profitable and market consumption more attractive.

These results show that, under certain conditions, an improvement in formal institutions that increase the return to market investment and decrease the fixed cost of participating in market investment results in more income which increases involvement in non-market exchange, even when more crowding out occurs because better market-supporting institutions increase the marginal utility of market consumption. Thus, institutions that improve the efficiency of market investment have positive spillovers in non-market exchanges and enhance overall welfare.

Our results provide insights into long-term economic development and the relevance of market-supporting institutions for it. Given the complementarity highlighted in our analysis, strong markets can enhance non-

[8]Crowding out here refers to the level of participation in the case where both exchanges are active relative to that in the case where only one of the markets is available.

market exchange rather than impede it. Therefore, it could be beneficial to invest in robust market-supporting institutions for more effective economic modernization and the maintenance of efficient levels of non-market exchange. Our analysis shows that it is welfare-maximizing to invest in the quality of market-supporting institutions, when initial endowments are not excessively small and individuals are not too impatient. 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 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 a type of formal enforcement in repeated game 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 maximizes cooperation and shows that grim-trigger 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 undermines 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 costs when the majority choose anonymous markets and raises them when few engage in them.[10] The fact that a more efficient market exchange un-

[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 that the complementarity between formal and informal enforcement depends on the institutional setting studied at both the theoretical and empirical levels. See, Corts (2018) for a detailed review of 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.

dermines 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 income generative capacity that can be spent in both, in either, or neither type 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 cheating on a market task results in a community punishment consisting of ostracism, which strengths incentives to comply with the market task and gives rise to the complementarity between formal and informal enforcement.[12]

As we do, they study the welfare maximizing institutions and, as in Kranton (1996), participating in the market or community task are mutually exclusive. However, in our model, individuals can simultaneously participate in market and non-market exchange. In contrast, 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 resource scarcity plays 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 expenditure depends on how many others choose the non-market exchange and whether or not they undertake a market exchange. The equilibrium depends on whether the network and market exchange are complements or substitutes. The model assumes this to be exogenous. They discuss several real-life interesting examples regarding when actions are complements or substitutes.

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 for 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, in contrast to the Chinese system, which 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, supporting 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 potentially contradictory predictions could be explained within the confines of our model in

[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.

light of the different institutional settings in which they happen.

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 literature in that it provides a different strategic link between market and non-market exchange and market-supporting institutions in a setting where they are independent of each other and both types of exchanges generate benefits and compete for funds, rather than looking at circumstances under which either of them flourishes. The strength of this mechanism rests on the quality of market-supporting institutions and individuals' income levels–observable variables that are 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, in the presence of markets, they can invest in a one-period technology that entails a fixed cost and yields a return before consumption is chosen. After the investment returns are realized, individuals simultaneously decide how much of their resources to allocate to non-market and market expenditures.

Non-market Exchange In each period t, if individual i chooses a non-market expenditure $x_i \in \Re_+$, he gets a utility $-x_i$ and his expenditure benefits every other individual $j \neq i$ by providing them with a utility $f(x_i)$, where $f : \Re_+ \to \Re_+$ is an increasing, strictly concave, bounded, and differentiable function satisfying $f(0) = 0$ and $f_1(0) > 1$, where f_1 denotes the partial derivative of f to x_i. 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 cannot benefit from non-market expenditure.[13]

Market exchanges Anonymous markets provide an investment and a consumption opportunity. In each period t, if individual i invests $y_i \in \Re_+$ in the market investment, he gets a payoff $g(y_i;\psi) - y_i$, where $\psi \in \Re_+$ is a parameter that measures the efficiency of the investment technology. The return 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 return is strictly increasing in y_i, twice-continuously differentiable, strictly concave, and satisfies the following: $g_1(0;\psi) > 1$, where g_1 denotes the partial derivative of g to y_i. This implies that a positive market investment is optimal when the fixed cost of market investment is zero,

Furthermore, $g(0;\psi) = 0$, $g_\psi(\cdot) > 0$, and $g_{1\psi}(\cdot) \geq 0$. Hence, as ψ rises, the marginal payoff and the payoff of itself increases. Because of this, the inverse of ψ could represent, for instance, regulations affecting the investment's efficiency, such as taxes levied on investments, or regulations that impose rigidity in the relationship between employers and employees. It also could capture the probability that the payoff occurs as agreed on. Participating in market investment technology entails a fixed cost per individual equal to ξ. The lower ξ, the higher the quality of market-supporting institutions regarding the investment technology since this makes it cheaper to participate in the formal market.

Markets also offer the possibility of anonymous market consumption. When individual i chooses a market expenditure z_i, he gets a utility $u(z_i;\phi) - pz_i$, where p is the price of z_i, ϕ captures the quality of institutions regarding anonymous consumption such as the quality of consumers' protection laws, enforcement of the delivery of the quality produced, etc...The utility is strictly increasing in z_i, twice-continuously differentiable, strictly concave, and satisfies the following: $u(0;\phi) = 0$ and the following Inada-type condition $u_1(0;\phi) > p$, and $u_{1\phi} \geq 0$, where u_1 denotes the partial derivative of u to z_i.

Thus, the utility of individual i is given by the quasi-linear utility function

$$U(x, z_i) = u(z_i;\phi) + \sum_{j \neq i} f(x_j;n) + k_i,$$

where $k_i = w + m_i(g(y_i;\psi) - y_i - \xi)$ and $m_i \in \{0,1\}$ takes the value 1 when the individual i chooses to participate in the market investment. Thus, the marginal utility from market consumption is independent of non-market consumption's utility. This is meant to avoid a mechanical connection between market and non-market consumption. We will discuss the role of complementarities/substitutability in the robustness

[13] An example of this type of expenditure is rotating savings and credit associations (Roscas), which are informal financial mechanisms found all over the world that are primarily used to save up for the purchase of durable goods (see Besley, Coate, and Loury (1993) for a model of Roscas).

[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.

section.

There are three different market institutions, two affecting the investment opportunity (ξ, ψ) and one influencing the utility of market consumption ϕ.

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 Prisoner' Dilemma. Thus, non-market exchange doesn't emerge from inherent characteristics of individuals, such as trustworthiness; rather, it results from individuals' self-interested enforcement mechanisms made possible by 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, non-market exchange could also consider both investment and consumption opportunities as market exchange does. This will not change the result as long as the non-market investment does not fully crowd out the market investment. This is a sensible scenario because non-market investment must be self-enforcing and therefore it will be limited by the community enforcement power. In most settings, this will be weaker than formal enforcement power. Furthermore, when both types of investment are considered, an improvement in market-supporting institution ψ will, ceteris paribus, crowd out non-market investments. This will give this institution a more prominent role. Thus, we have ignored the non-market investment opportunity to emphasize the role of market-supporting institutions and to keep the model as simple as possible.

Thirdly, the model deliberately excludes savings to maintain simplicity and keep it within the framework of repeated games. Considering them would alter the recursive structure of the model. This will make 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.

Fourthly, the assumption has been made that the payoff from the non-market expenditure is independent of the payoff from the market expenditure. 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.

Fifthly, 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 markets and none, others participating exclusively in either market or non-market exchange, the complexity introduced might outweigh the additional insights gained.

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

4 Benchmarks

4.1 A Non-Market Exchange Economy

4.2 The Equilibrium

In a non-market exchange economy, individuals engage exclusively in non-market exchange activities. Market exchange is 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. Consequently, in this economy, upon deviation, an individual is forced to live in autarky, and his expenditure is limited to the endowment w. This is the harshest possible punishment.

When individuals play grim-trigger strategies, each individual's expenditure in the non-market expenditure $x_i \in \Re_+$ is incentive compatible in each period, provided that other individuals' action profile is x_{-i}, if and only if agent i prefers to spend x_i than investing zero; that is,

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

Let's define $x(\delta)$ as the largest symmetric solution to the incentive constraint when the resource constraint is ignored and x^{fb} as the expenditure that maximizes welfare; that is, $x^{fb} \equiv \operatorname{argmax}_{x\in\Re_+^{n+1}} \sum_{i=1}^{n+1}\{\sum_{j\neq i} f(x_j) - x_i\}$.[15] Observe that $x(\delta)$ rises with δ and therefore there exits a threshold δ^{fb} such that $x(\delta) \leq x^{fb}$ for all $\delta \leq \delta^{fb}$.

From here onwards, we will assume that δ is such that there is a strictly positive self-sustainable non-market expenditure. This demands the following assumption.

Assumption 1. *The discount factor δ is such that $\delta n f_1(0) > 1$.*

As is in any repeated game, there are multiple equilibria, among which the repetition of the static equilib-

[15] The concavity of f and the Inada-type conditions ensures that the optimal exists, and is interior and unique. When the equilibrium is symmetric, we make the abuse of notation by denoting the symmetric equilibrium by x^{fb}.

rium is one of them, the welfare-maximizing equilibrium and the Pareto dominant equilibrium are others.[16] Following, for instance, Acemoglu and Wolitzky (2019) and Acemoglu and Wolitzky (2020, 2021),we characterize the highest incentive-compatible welfare.[17]

The non-market expenditure profile solves the following problem

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

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

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

4.3 Welfare

Let's define the endowment level $w^n = \min\{x^{fb}, x(\delta)\}$.[18] 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

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

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

[16]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).

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

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

4.4 A Market-Exchange Economy

4.5 The Equilibrium

Here, we derive the equilibrium when non-market exchange is not available. There are two important features of this equilibrium. First, this equilibrium payoff will be the same as the one emerging during the punishment phase in a market and non-market exchange economy. Second, the equilibrium payoff is identical to that of the static equilibrium of an economy that allows for both non-market and market exchange. These results arise because an individual's benefit from the non-market exchange is independent of his expenditure in non-market exchange and community punishments are not applicable in a static game.

Provided that individual i's endowment plus the net return of the market investment is k_i; that is, $k_i = w + m_i(g(y_i;\psi) - y_i - \xi)$, he chooses the expenditure that solves the following problem[19]

$$\max_{z_i \in \Re_+} \left\{ u(z_i;\phi) - pz_i + k_i \right\} \text{ subject to } pz_i \leq k_i$$

It is straightforward to check that an individual chooses to consume z^{mu} units, where this solves $u_1(z_i;\phi) - p = 0$ whenever $z^{mu} \leq k_i$ and chooses to consume the totality of his income otherwise. Let $z(k_i) \equiv \min\{z^{mu}, p^{-1}k_i\}$. Observe that $z(k_i)$ is non-decreasing in k_i.

Because individuals anticipate this, they choose to invest in the market technology to solve the following problem

$$\max_{(y_i,m_i) \in \Re^2_+ \times \{0,1\}} \left\{ u(z(k_i);\phi) - pz(k_i) + k_i \right\}$$

subject to

$$k_i = w + m_i(g(y_i;\psi) - y_i - \xi),$$

$$y_i \leq w.$$

The first-order condition is given by

$$\Big((u_1(z(k_i);\phi) - p) \frac{\partial z(k_i)}{\partial k_i} + 1 \Big) \big(g_1(y_i;\psi) - 1 \big) = 0.$$

Because the first term in the parenthesis is strictly positive since $z(k_i)$ is non-decreasing and the term multiplying in it is non-negative, the term in the second parenthesis must be zero. Let's denote the unique solution to $g_1(y_i;\psi) - 1 = 0$ by y^{mu}. Because g is strictly concave and satisfies the Inada-type conditions,

[19] 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.

it is straightforward to show that y^{mu} exists, and is unique and non-decreasing in ψ. This solution is feasible whenever $y^{mu} \leq w$.

Thus, provided that the individual chooses to participate in the market investment, there exists an endowment level defined by $w^{mu} \equiv \max\{0, y^{mu} + \xi + pz^{mu} - g(y^{mu}; \psi)\}$ such that the individual invests y^{mu} and consumes z^{mu} whenever $w \geq w^{mu}$. In contrast, when $y^{mu} + \xi \leq w < w^{mu}$, he invests $y = y^{mu}$ and consumes $z^{mc} = p^{-1}(g(y^{mu}; \psi) + w - y^{mu} - \xi)$.[20] Let's define $w^{mb} \equiv y^{mu} + \xi$.

In what follows, we will assume that it is privately optimal to participate in the market investment when unconstrained. Thus,

Assumption 2. $g(y^{mu}; \psi) - y^{mu} - \xi > 0$.

Finally, when $w < w^{mb}$, if the individual chooses to invest, he invests $w - \xi$ and consumes $z = p^{-1}g(w - \xi; \psi)$. He opts out of the market investment whenever

$$u(p^{-1}w; \phi) > u(p^{-1}g(w - \xi; \psi); \phi).$$

Hence, the individual opts out whenever $w > g(w - \xi; \psi)$. Because the $g(w - \xi; \psi) - w$ rises with w for all $w \leq w^{mb}$, there exists an endowment threshold, denoted by w^{mc}, such that the payoff from opting out of market investment exceeds the same payoff from participating in it for all $w < w^{mc}$.[21]

From the preceding discussion and results, we deduce that the equilibrium is given by[22]

Proposition 2.

$$(x^m, z^m, y^m, m^m) = \begin{cases} (0, z^{mu}, y^{mu}, 1) & \text{if } w \geq w^{mu}, \\ (0, z^{mc}, y^{mu}, 1) & \text{if } w^{mb} \leq w < w^{mu}, \\ (0, p^{-1}g(w - \xi; \psi), w - \xi, 1) & \text{if } w^{mc} \leq w < w^{mb}, \\ (0, p^{-1}w, 0, 0) & \text{if } w < w^{mc}. \end{cases}$$

where $z^{mc} = p^{-1}(g(y^{mu}; \psi) + w - y^{mu} - \xi)$.

The equilibrium is such that when the endowment is too small, individuals refrain from participating in the market investment and only engage in market consumption. They opt out because the fixed cost represents a large share of the endowment. Otherwise, they participate in market investment. They invest the full endowment in the market technology when constrained or they invest y^{mu} when $w \geq w^{mb}$. Their expendi-

[20]The superscript m stands for market exchange and u for unconstrained.
[21]The superscript mc stands for market constrained.
[22]Formal proofs can be found in the Appendix.

ture is equal to the total income when $w < w^{mu}$; otherwise, their expenditure is the one that maximizes the utility $u(z;\phi)$ and the income surplus is spent on the composite good.

4.6 Comparative Statics

Next, we derive the comparative statics concerning (ϕ, ψ, w, ξ).

Proposition 3.

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

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

iii. If $w \in [w^{mc}, w^{mb})$, z^m increases with (w, ψ, ϕ) and falls with (ξ, p).

iv. if $w < w^{mc}$, z^m is independent of (ψ, ϕ, ξ), rises with w, and falls with p.

The results with regard to ψ follow from the concavity of g, $g_\psi > 0$, and $g_{1\psi} \geq 0$. Hence, an increase in ψ impacts the equilibrium market investment because, holding this constant, increases its return and marginal return. An increase in ϕ increases market consumption in z whenever the income constraint allows it since it raises the marginal utility of z. A rise in ξ decreases the amount invested in the market when the individual is constrained, which decreases consumption. A larger endowment allows more investment and consumption when constrained.

4.7 Welfare

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

$$V^m = \begin{cases} u(z^{mu};\phi) - pz^{mu} + g(y^{mu};\psi) + w - y^{mu} - \xi & \text{if } w \geq w^{mu}, \\ u(z^{mc};\phi) & \text{if } w \in [w^{mb}, w^{mu}), \\ u(p^{-1}g(w-\xi;\psi);\phi) & \text{if } w \in [w^{mc}, w^{mb}), \\ u(p^{-1}w;\phi) & \text{if } w \in [0, w^{mc}). \end{cases}$$

Then, we have the following result.

Proposition 4. *Suppose Assumption holds.*

i. When $w \geq w^{mc}$, V^m increases with (w, ψ, ϕ) and falls with (ξ, p).

ii. When $w < w^{mc}$, V^m rises with (w, ϕ), is independent of (ψ, ξ), and falls with p.

An increase in w raises the equilibrium payoff because it allows either a larger investment or a larger consumption or both, and when w is low enough so that individuals choose to opt out of the market investment, the increase in w may stop them from doing so. An increase in the fixed cost of participating in the market investment has the opposite effect.

An increase in ψ raises the market return on the investment. This results in a larger income spent on consumption in the good z or the composite good. When the endowment is small enough so that the individual opts out of the market investment, an increase in ψ does not impact the equilibrium.

An increase in ϕ raises the utility and the marginal utility and therefore, ceteris-paribus, increases the equilibrium payoff. When the individual is unconstrained, this results in a larger consumption of the z good.

Hence, in a purely market-exchange economy, the equilibrium payoff is non-decreasing with the quality of any market-supporting institutions $(\phi, \psi, -\xi)$. The threshold below which individuals are resource-constrained and the one below which they opt out of the market investment are both non-increasing with them.

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 market-exchange economy after a deviation regarding non-market expenditure is observed.[23]

Because individuals play grim-trigger strategies, each individual's non-market expenditure $x_i \in \Re_+$ is incentive-compatible in each period, provided that he chooses market expenditure z_i, he has resources in an amount k_i, and the strategy profile of the other individuals is (x_{-i}, z_{-i}) if and only if individual i prefers the expenditure x_i than any other expenditure. Hence, the following must be satisfied:

$$\begin{aligned} &\sum_{j \neq i} f(x_j) - x_i + u(z_i; \phi) - pz_i + k_i \geq (1-\delta)\Big(\sum_{j \neq i} f(x_j) + u(z_i; \phi) - pz_i + k_i\Big) + \delta V^m \\ &\Longrightarrow \\ &x_i \leq \delta\Big(\sum_{j \neq i} f(x_j) + u(z_i; \phi) - pz_i + k_i - V^m\Big), \end{aligned} \tag{3}$$

where V^m is the equilibrium payoff of a market-exchange economy.

It readily follows from this that, ceteris-paribus, an increase in the equilibrium payoff of the market-

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

exchange economy; that is, an increase in V^m, crowds out non-market expenditure since deviations are more tempting.

From here onwards, we will focus on symmetric equilibrium. Let's define $x(\delta, z_i, k_i)$ as the largest solution to the incentive constraint in equation (3) when this exists, otherwise $x(\delta, z_i, k_i)$ is set to zero. When $x(\delta, z_i, k_i) > 0$, this increases with z_i for all $z_i \leq z^{mu}$ since the payoff from market consumption rises. It also increases with (δ, w) and falls with ξ. An increase in δ implies that the future is more valuable and therefore the loss from entering the punishment phase is higher. An increase in w implies, ceteris paribus, larger consumption. In contrast, an increase in the fixed cost ξ results, ceteris paribus, in less consumption.

Let's define $\delta^u(k_i)$ as the lowest discount factor such that $x^{fb} = x(\delta, z^{mu}, k_i)$; that is, the lowest δ such that the incentive-compatibility constraint holds when $x = x^{fb}$ and $z = z^{mu}$.[24]

Here, we also select the symmetric welfare-maximizing incentive-compatible profile (x, y, m) satisfying individuals' resource constraints. Thus, the profile solves the following problem

$$\max_{(x,z)\in\{\Re^2_+\}^{n+1}} \sum_{i=1}^{n+1} \Big\{ \sum_{j\neq i} f(x_j) - x_i + u(z_i;\phi) - pz_i + k_i \Big\}$$

subject to $\forall\, i$

$$x_i \leq \delta\Big(\sum_{j\neq i} f(x_j) + u(z_i;\phi) - pz_i + k_i - V^m \Big),$$

$$x_i + z_i \leq k_i.$$

When resources are sufficiently large, the welfare-maximizing consumption profile consists of choosing market expenditure that maximizes the market utility $u(z_i; \phi) - pz_i$ and the minimum between the welfare-maximizing and the largest self-sustainable non-market expenditure, which is the former whenever $\delta \geq \delta^u(k_i)$.

Let's define $x^{nmu}(\delta, k_i) \equiv x(\delta, z^{mu}, k_i)$.[25] Then, this is feasible whenever $w \geq w^{nmu}(\delta) \equiv z^{mu} + \min\{x^{fb}, x^{nmu}(\delta)\} - m(g(y; \psi) - y - \xi)$.[26]

When individuals do not have enough resources to implement this solution, the expenditures are deter-

[24]Because $x(\delta, z, k_i)$ rises with δ and $u(z^{mu}; \phi) - z^{mu} + k_i - V^m \geq 0$ and f is concave, δ^u exists and is unique.

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

[26]Whenever $w \geq w^{nmu}(\delta)$, the welfare-maximizing consumption is $z_i = z^{mu}$. This is the same as that in the market exchange economy. The same occurs with the income. Thus, $u(z_i; \phi) - pz_i + k_i - V^m = 0$. This, together with Assumption 1, ensures that $x^{nmu}(\delta) > 0$.

mined by the following first-order conditions

$$x_i : \sum_{j \neq i} f_1(x_i) - 1 + \mu_i(\delta \sum_{j \neq i} f_1(x_i) - 1) - \lambda_i = 0,$$
$$z_i : u_1(z_i; \phi) - p + \mu_i \delta(u_1(x_i; \phi) - p) - \lambda_i = 0$$

where λ_i is the Lagrange multiplier for the resource constraint and $\mu_i \geq 0$ is the Lagrange multiplier for the incentive-compatibility constraint.

Observe that $\lambda_i = (1 + \mu_i \delta)(u_1(z_i; \phi) - p) > 0$, whenever $z < z^{mu}$. Thus, whenever $w < w^{nmu}(\delta)$, the resource constraint binds. Let's denote the solution when the incentive constraint does not bind by $(x_i^c(k_i), z_i^c(k_i))$ and observe that $x_i^c(k_i) = k_i - z_i^c(k_i)$, and when the incentive constraint binds by $(x_i(k_i, \delta), z_i(k_i, \delta))$ and observe that $x_i^c(k_i, \delta) = k_i - z_i^c(k_i, \delta)$. Finally, let's denote the optimal consumption by $(x(k_i), z(k_i))$.

When resources are abundant, welfare is maximized by choosing actions that maximize both market and non-market utility, ensuring incentive compatibility. In cases where resources are moderate, the optimal strategy involves equalizing the marginal utility to market expenditure minus the price to the marginal utility to non-market expenditure minus its price, provided non-market exchange remains incentive-compatible. If not, it is welfare-maximizing to opt for the largest incentive-compatible non-market expenditure and to allocate the remaining income to market expenditure.

Provided that the optimal consumption is $(x(k_i), z(k_i))$, the choice of investment in the market technology solves the following problem

$$\max_{(y,m) \in \{\Re_+ \times \{0,1\}\}^{n+1}} \sum_{i=1}^{n+1} \Big\{ \sum_{j \neq i} f(x_i(k_i)) - x_i(k_i) + u(z_i(k_i); \phi) - p z_i(k_i) + k_i \Big\}$$
$$\text{subject to } \forall\, i$$
$$k_i = w + m_i(g(y_i; \psi) - y_i - \xi),$$
$$y_i \leq w.$$

The first-order condition is as follows

$$\Big(n f_1(x(k_i)) - 1\Big) \frac{x_i(k_i)}{\partial k_i} + (u_1(z(k_i); \phi) - p) \frac{z_i(k_i)}{\partial k_i} + 1\Big) m_i \big(g_1(y_i; \psi) - 1\big) \geq 0.$$

It is easy to check that whenever it is optimal not to step out of the market investment, the first term in parenthesis is positive since the first two terms are non-negative because consumption is non-decreasing in available income and consumption is constrained. Thus, the optimal investment is $y_i = y^{mu}$ whenever

$w \geq y^{mu} + \xi$ and is $y_i = w - \xi$ otherwise.

Thus, provided that the individual participates in the market investment, there exists an endowment level defined by $w^{mnu} \equiv \max\{0, \min\{x^{fb}, x^{nmu}(\delta)\} + y^{mu} + \xi + pz^{mu} - g(y^{mu}; \psi)\}$ such that it is optimal to invest y^{mu} and to consume $(z^{mu}, \min\{x^{fb}, x^{nmu}(\delta)\})$ whenever $w \geq w^{mnu}$. In contrast, when $y^{mu} + \xi \leq w < w^{mnu}$, it is optimal to invest $y = y^{mu}$ and to consume $(z^c(w + g(y^{mu}; \psi) - y^{mu} - \xi), x^c(w + g(y^{mu}; \psi) - y^{mu} - \xi))$.[27] Let's denote $w^{nmb} \equiv y^{mu} + \xi$.

To simplify the analysis, we will assume that δ is such that $x_i(k_i, \delta) > 0$. This requires the following assumption

Assumption 3. *The discount factor δ is such that $\delta\big(nf_1(0) - (u_1(0; \phi) - p)p^{-1}\big) > 1$.*

When $w < w^{nmb}$, if the individual chooses to invest in the market, he invests $w - \xi$ and consumes $(z^c(g(w - \xi; \psi)), x^c(g(w - \xi; \psi)))$. He chooses not to invest in the market when

$$nf(x_i^c(w)) + u(z_i^c(w); \phi) \geq nf(x_i^c(g(w - \xi; \psi)) + u(z_i^c(g(w - \xi; \psi); \phi).$$

Lemma 1. *Opting out of the market investment is optimal whenever $w < w^{nmc}$, with $w^{nmc} = w^{mc}$.*

When resources are scarce, it is optimal to refrain from market investment to save the fixed costs associated with it since paying that and investing will result in less disposable income than the initial endowment. This, however, does not preclude individuals from engaging in market and non-market expenditure. However, market expenditure is crowded out by non-market expenditure and non-market expenditure is crowded out by market expenditure. The individuals choose expenditure to equalize the marginal utility to market expenditure minus its price p to the marginal utility to non-market expenditure minutes its price 1.

From the discussion above, we deduce the following result.

Proposition 5. *The equilibrium profile regarding the market and non-market expenditure is given by:*

$$(x^{nm}, z^{nm}, y^{nm}, m^{nm}) = \begin{cases} (x^{nmu}, z^{mu}, y^{mu}, 1) & \text{if } w \geq w^{nmu}, \\ (x^{nmc}, p^{-1}(w + g(y^{mu}; \psi) - y^{mu} - \xi - x^{nmc}), y^{mu}, 1) & \text{if } w^{nmb} \leq w < w^{nmu}, \\ (x^{nmc}, p^{-1}(g(w - \xi; \psi) - x^{nmc}), w - \xi, 1) & \text{if } w^{nmc} \leq w < w^{nmb}, \\ (x^{nmc}(w), w - x^{nmc}(w), 0, 0) & \text{if } w < w^{nmc}, \end{cases}$$

where $x^{nmu} = \min\{x^{fb}, x^{nmu}(\delta, y^{mu}, 1)\}$

When individuals are rich and the patience level, δ, exceeds the threshold δ^{nmu}, they select the welfare-maximizing non-market expenditure. Alternatively, individuals choose the largest self-sustainable non-

[27] The superscript n stands for non-market exchange and u for unconstrained.

market expenditure when the patience level falls short of the threshold. In either situation, they possess abundant resources to pay for the market expenditure that maximizes the market payoff. When $\delta < \delta^{nmu}$, there is under-investment in the non-market expenditure even though individuals have the resources to consume that socially optimal amount, but that will induce them to renege on their non-market expenditure.

For individuals who are not rich, two scenarios emerge. In the first scenario, their discount factor is such that it allows them to simultaneously choose the market and non-market expenditures so that the marginal utility of the last dollar spent on market expenditure delivers the same marginal utility of non-market expenditure. This results in under-investment in both the non-market and market expenditure, yet consumption for both is positive. In the second scenario, the discount factor is low enough so the above solution violates the non-market expenditure's incentive-compatibility constraint, prompting individuals to choose the highest incentive-compatible non-market expenditure. Any income surplus is allocated to market expenditure. Thus, the marginal utility to market expenditure is lower than the marginal utility to non-market expenditure. In both cases, market exchange crowds out non-market exchange relative to the non-market exchange economy and vice-versa.

5.2 Comparative Statics

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

Proposition 6. *Suppose that $w \geq w^{nmu}$. Then,*

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

ii. z^{nm} *is independent of* (w, ψ, ξ)*, is non-decreasing with* ϕ*, and falls with* p.

iii. 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 socially optimal market and non-market expenditure are chosen. Thus, non-market expenditure is independent of market expenditure and market-supporting institutions (ϕ, ψ, ξ). When individuals are not as patient, the equilibrium non-market expenditure is the largest self-sustainable non-market expenditure. This could depend on the market-consumption level and the market-supporting institutions through the incentive compatibility constraint. However, because $w^{nmu} > w^{mu}$, the payoff from market expenditure in the equilibrium of the market and non-market exchange economy; i.e. $u(z^{mu}; \phi) - z^{mu} - \xi$, is identical to that in a purely market-exchange economy and the market investment and its return are also the same. Hence, the non-market expenditure's incentive compatibility constraint is independent of (ψ, ξ, ϕ, w). Because the equilibrium selected is such that market expenditure maximizes the market payoff, market expenditure rises with ϕ since $u_1(z; \phi)$ increases with ϕ.

Proposition 7. *Suppose that $w \in [w^{nmc}, w^{nmu})$. Then,*

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

ii. z^{nm} *rises with* (w, ψ, ϕ) *and falls with* (ξ, p).

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

When the incentive constraint does not bind, the optimal expenditure occurs where the marginal utilities minus their corresponding prices are equal; otherwise, non-market expenditure is the largest self-sustainable consumption and the remaining income is spent on market consumption. In the former case, market consumption rises and non-market falls with ψ since this only increases the marginal utility of market consumption. Any institutional change that increases income raises both market and non-market expenditure. Thus, they increase with (ψ, w) and fall with ξ.

When the incentive-compatibility constraint binds, an improvement in any market-supporting institutions, holding expenditures constant, has two effects: an increase in the payoff during the punishment phase, V^m, which tightens non-market expenditure's incentive constraint, and an increase in the income that, ceteris paribus, softens the incentive constraint. This makes a larger non-market and market expenditure feasible.

Because the non-market expenditure is positive and the income is the same in a market and non-market exchange economy than in a purely market exchange economy, $z^{nmc} < z^m$. This means the punishment payoff is higher than the market payoff. This, plus the fact u is concave and the marginal utility of z raises with ϕ, implies that z^{nmc} rises with $\{\phi, w\}$ and falls with (ξ, p). This, plus the fact that non-market expenditure is equal to the income minus market expenditure, explains the behavior of x.

Proposition 8. *Suppose that $w < w^{nmc}$. Then,*

i. x_s^{nm} *rises with* (w, p)*, falls with* ϕ *and is independent of* (ψ, ξ).

ii. z^{nm} *rises with* (w, ϕ)*, is independent of* (ψ, ξ)*, and falls with* p.

iii. y^{nm} *is independent of* (w, ξ, ϕ, ψ)

Because, as in the preceding cases, optimal consumption is chosen so that the marginal utility to market expenditure minus its price equals the marginal utility to non-market expenditure minus its price when the incentive constraint does not bind, the intuition is the same as the one for the result in Proposition 7, with the difference that ψ plays no role in the equilibrium since individuals opt out of the market investment.

5.3 Welfare

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

$$V^{nm} = \begin{cases} nf(x^{nmu}) + u(z^{mu};\phi) - pz^{mu} + g(y^{mu};\psi) + w - y^{mu} - \xi & \text{if } w \geq w^{nmu}, \\ nf(x^{nmc}) + u(p^{-1}(w + g(y^{mu};\psi) - y^{mu} - \xi - x^{nmc});\phi) & \text{if } w \in [w^{nmb}, w^{nmu}), \\ nf(x^{nmc}) + u(p^{-1}(g(w-\xi;\psi) - x^{nmc});\phi) & \text{if } w \in [w^{nmc}, w^{nmb}), \\ nf(x^{nmc}) + u(p^{-1}(w - x^{nmc});\phi) & \text{if } w \in [0, w^{nmc}). \end{cases}$$

The next result deals with the comparative statics regarding welfare.

Proposition 9. *If $w \geq w^{nmc}$, V^{nm} increases with (w, ψ, ϕ) and falls with (p, ξ), while if $w < w^{nmc}$, V^{nm} rises with (w, ϕ), is independent of (ψ, ξ), and falls with p.*

As expected, welfare is always increasing in the endowment and non-increasing in the fixed cost of using the market. For market-supporting institutions (ϕ, ψ), welfare is non-decreasing with them since the former increases the marginal utility of market expenditure and the latter increases the marginal return to the market investment. Thus, for any endowment $w \geq w^{nmc}$, improvements in market-supporting institutions result in larger welfare and lower w^{nmc}, w^{nmb}, and w^{nmu}.

6 The Relevance of Market-Supporting Institutions

6.1 Welfare Comparisons

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

Proposition 10. *$V^{nm} > V^m$ for all w and there exists a discount factor threshold $\delta^{mn}(w)$ such that $V^{nm} > V^n$ for all w whenever $\delta > \delta^{nm}(w)$; otherwise, there is an endowment threshold $w^* \in (0, w^{nmu})$ such that $V^{nm} > V^n$ for all $w > w^*$.*

Welfare in a market and non-market exchange economy is larger than in a purely market exchange economy since the equilibrium in the latter economy is always possible in the former economy and is never played since $x^{nm} > 0$ for all $w > 0$.

When the discount factor is such that the incentive-compatibility constraint does not bind, welfare in a market and non-market exchange economy is larger than in a purely non-market exchange economy since the equilibrium in the latter economy is always possible in the former economy but is never played since $z^{nm} > 0$ for all $w > 0$.

Welfare in a market and non-market exchange economy is smaller than in a purely market exchange economy when the discount factor is low enough so that the incentive-compatibility constraint binds and the endowment is lower than a given threshold. This happens because whenever $w < w^{nmu}$, the incentive-compatibility constraint in a market and non-market exchange economy is tighter than in a purely market exchange economy and total income is the same. The reason is that the whole income is spent on non-market expenditure in a purely non-market exchange economy but between market and non-market expenditure in an economy with both types of exchanges. Thus, $u(z_i;\phi) - pz_i + k_i - V^m < 0$ and therefore $\sum_{j\neq i} f(x_j) + u(z_i;\phi) - pz_i + k_i - V^m < \sum_{j\neq i} f(x_j)$ for all $w > 0$. Because of assumption 3, when the endowment is sufficiently low non-market expenditure is so restricted relative to that in a purely non-market exchange economy and market expenditure is small enough that cannot compensate for the loss in non-market utility due to a tighter incentive constraint.

Hence, the introduction of anonymous formal markets in a non-market exchange economy results in partial crowding out and this is welfare-enhancing when the discount factor is large enough since markets either enlarge investment possibilities, even though participating in market investment entails a fixed cost, provide ampler consumption opportunities, or both. In contrast, when the discount factor and the endowment are both small enough, welfare is lower because the punishment payoff in an economy with both types of exchange makes reneging on non-market exchange more attractive and individuals choose a positive expenditure in each exchange.

6.2 The Development Process

This sub-section delves into the implications of investing in market-supporting institutions (ψ, ϕ, ξ) on 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^*. However, this initial transition comes at the cost of crowding out non-market exchange relative to a purely non-market exchange economy. As income and market-supporting institutions improve, societies will take advantage of both market and non-market exchange.

Because establishing robust market-supporting institutions typically necessitates substantial initial investments (fixed costs), transitioning to a modern economy is difficult when individuals are poor because there are no incentives to make marginal institutional improvements. Escaping this equilibrium requires positive income shocks and a large scale so that the economy is rich 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., $w \geq w^*$), where improvements in market-supporting institutions are welfare-enhancing. Furthermore, because the endowment thresholds do not increase with the quality of market-supporting institutions, they not only allow for modernization and unconstrained expenditure but also enhance the economy's resilience to negative shocks to the endowments.

The empirical literature regarding the relation between institutions, cultural traits, and economic variables is large. The evidence that cultural norms and beliefs affect economic behavior together with the evidence documenting the long-lasting effect of formal and informal institutions on different cultural traits, suggests that culture plays a role in explaining persistent differences in countries' economic performance. Choi and Storr (2020) design an experiment with personal exchange and anonymous exchange. They find that in the market where exchanges are more personal, previous experiences are important as determinants of future trust and reciprocity, meanwhile, in the case where interactions are more impersonal, they are not affected by the nature of previous market interactions.

Carlin, Dorobantu, and Viswanathan (2009) show that when the value of social capital is high, government regulation and trustfulness are substitutes. On the other hand, when the value of social capital is low, regulation and trust may be complements. Aghion et al. (2010) find that distrust and institutions co-evolve and distrust has an impact not only on regulation but also on the demand for regulation. Pinotti (2012) documents, holding constant the component of demand for government intervention due to trust across countries, that regulation is no longer associated with worse economic outcomes. The same result is confirmed when he uses population size as an alternative source of variation in regulation. Bidner and Francois (2011) find that trust strongly depends on the country's population size. This is because the creation of institutions requires fixed costs and, thereby, introducing an institution becomes efficient when the scale is big enough to cover the fixed costs of creating and running it (Demsetz, 1967).

7 Discussion

Firstly, we could have assumed a different market equilibrium selection criteria that exacerbates the crowding 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 market expenditure that maximizes their individual's payoff and, if after doing so, resources are not fully exhausted, individuals choose the non-market expenditure that maximizes welfare subject to the incentive compatibility constraint. This is the minimum between the largest self-sustainable non-market consumption $x(\delta, y, m)$, the welfare-maximizing non-market consumption x^{fb}, and the income not spent in market expenditure.[28] This criterion provides the most adverse scenario for welfare-enhancing crowding out and complementarity between market and

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

non-market exchange since the crowding out effect is the strongest. So, we can view this selection criterion as more resilient to community enforcement failures, as individuals turn to non-market exchange only after exhausting the private benefits of formal enforcement.

Secondly, the model assumes that non-market exchange involves everyone in the community. However, it is also 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 and the whole community participates in market exchange.

Thirdly, we assume there are 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 interpreted 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.

Fourthly, we have assumed that the payoff of market investment 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 $y \equiv (y_1, \ldots, y_{n+1})$.[29] In this case, there would be an inefficient market investment.

Fifthly, 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 societies with highly inpatient individuals and low incomes are better off in a purely non-market exchanges economy since the marginal benefit of market investment is outweighed by fixed costs and the fact that markets provide a better fall-back position upon reneging, which reduces self-sustainable non-market exchange expenditure relative to that in non-market exchange economy. When the endowment is larger, the benefit from market investment and expenditure variety provided by market exchange compensates for the lower non-market exchange expenditure. When individuals are highly patient, the incentive

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

constraint does not bind and individuals benefit from both exchanges.

Consequently, partial crowding out of non-market exchange, relative to a non-market exchange economy, and crowding out of market exchange, relative to a market-exchange economy, occurs whenever individuals are income-constrained. Crowding out of market exchange never results in lower welfare and crowding out of non-market exchange is welfare-decreasing when both the discount factor and the endowment are small.

These results provide insights into the ongoing debate on whether market expansion crowds out non-market exchange or enhances its benefits, and suggest a reassessment of the debate in terms of which institutional settings improve welfare and which ones have adverse effects.

The results also offer insights into a nation's development process. 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 welfare-enhancing. Societies in poverty may become trapped in low welfare non-market exchange equilibrium. Market-supporting institutions can facilitate escaping this by increasing the efficiency of market exchange, lowering market exchange fixed costs, improving investment returns, and providing better-quality goods.

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A Appendix

Proof of Proposition 2.

Lemma 2.

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 2. 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 $\phi^{-1}(g_1(y_i(k); \psi) - 1) \leq 0$, 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 $1 + \phi \geq g_1(y_i(d); \psi)$, 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 $1 + \phi > g_1(y_i(d); \psi)$ 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 $g_1(y_i(d); \psi) - \phi > 0$, which is always the case because $\phi \leq 1$, and decreases with ξ whenever $g_1(y_i(d); \psi) > 1$.[30]

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

$$\frac{1}{1 + \phi - g_1(y_i(d); \psi)} > 0$$

where the inequality follows from the fact that the denominator is positive. This, together with Assumption **??**, 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 easy to check that

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

$w^{mu}_{\psi} = \big(y^{mu}_{\psi}(1+\phi-g_1)+g_{\psi}\big)|_{y^{mu}} > 0$ since $1+\phi-g_1>0$ and

$$w^{mu}_{\phi} = -\frac{1}{(1+\phi)^2}\frac{g+w}{1+\phi-g_1}\Big|_{y^{mu}} < 0.$$

Last observe that the fact that $w + d^{mu}$ increases with w, together with Assumption **??**, 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 4.

$$V^m = \begin{cases} u(z^{mu};\phi) - pz^{mu} + g(y^{mu};\psi) + w - y^{mu} - \xi & \text{if } w \geq w^{mu}, \\ u(p^{-1}z^{mc};\phi) & \text{if } w \in [w^{mb}, w^{mu}), \\ u(p^{-1}g(w-\xi;\psi);\phi) & \text{if } w \in [w^{mc}, w^{mb}), \\ u(p^{-1}w;\phi) & \text{if } w \in [0, w^{mc}). \end{cases}$$

$z^{mc} = p^{-1}(g(y^{mu};\psi) + w - y^{mu} - \xi)$

If $w \geq w^{mu}$, $V^m_w = 1$, $V^m_{\xi} = -1$, $V^m_{\psi} = g_{\psi}(y^{mu};\psi) > 0$, $V^m_{\phi} = u_1(z^{mu};\phi) > 0$, and $V^m_p = z^{mu} > 0$

If $w < w^{mu}$,

$$V^m_w = u_1(z;\phi)\frac{\partial z^m}{\partial w}|_{z=z^m} > 0.$$

where $\frac{\partial z^{mc}}{\partial w} = p^{-1}$ and $\frac{\partial z^m}{\partial w} = p^{-1}g_1(w-\xi;\psi) > 0$.

$$V^m_{\xi} = u_1(z;\phi)\frac{\partial z^m}{\partial w}|_{z=z^m} > 0.$$

where $\frac{\partial z^{mc}}{\partial w} = -p^{-1}$ and $\frac{\partial z^m}{\partial \xi} = -p^{-1}g_1(w-\xi;\psi) > 0$.

$$V^m_{\psi} = u_1(z;\phi)\frac{\partial z^m}{\partial \psi}|_{z=z^m} > 0.$$

where $\frac{\partial z^{mc}}{\partial \psi} = p^{-1}g_{\psi}(y^{mu};\psi)$ and $\frac{\partial z^m}{\partial w} = p^{-1}g_{\psi}(w-\xi;\psi) > 0$.

$$V^m_{\phi} = u_{\phi}(z;\phi)|_{z=z^m} > 0.$$

and

$$V^m_p = -u_1(z;\phi)\frac{z^m}{p}|_{z=z^m} < 0.$$

□

Proof of Lemma 1. It is optimal not to step out of the market when

$$nf(x_i^c(w)) + u(z_i^c(w);\phi) > nf(x_i^c(g(w-\xi;\psi)) + u(z_i^c(g(w-\xi;\psi);\phi) > 0.$$

If $w = g(w-\xi;\psi)$, then opting out of the investment market provides the same utility than investing in the market project. It is easy to check that $g(w-\xi;\psi) - w$ rises with w for all $w \leq y^{mu} + \xi$ and therefore $g(w-\xi;\psi) - w > 0$ for all $w > w^{mc}$. Thus, at $w = w^c$, he is indifferent between opting out and investing.

Observe that

$$\frac{\partial x_i(k)}{\partial w} = \frac{u_{ii}}{nf_{ii} + u_{ii}} \frac{\partial k_i}{\partial w} \in (0,1)$$

where $\frac{\partial k_i}{\partial w} = 1$ if $k = w$ and $\frac{\partial k_i}{\partial w} = g_1(w-\xi;\psi)$ if $k = g(w-\xi;\psi)$,

$$\frac{\partial x_i(k,\delta)}{\partial w} = \frac{\delta(u_1(z_i(k,\delta);\phi)p^{-1}\frac{\partial k_i}{\partial w} - V_w^m)}{\delta(u_1(z_i(k,\delta);\phi)p^{-1} - nf_1(x_i(k,\delta))) + 1} \geq 0,$$

where the inequality follows from $\frac{\partial k_i}{\partial w} = 1$ if $k = w$ and $\frac{\partial k_i}{\partial w} = g_1(w-\xi;\psi)$ if $k = g(w-\xi;\psi)$,

$$V_w^m = u_1(z;\phi)\frac{\partial z^m}{\partial w}|_{z=z^m} > 0,$$

where $\frac{\partial z^{mc}}{\partial w} = p^{-1}$ and $\frac{\partial z^m}{\partial w} = p^{-1}g_1(w-\xi;\psi) > 0$, $z^m \geq z_i(k,\delta)$, and $\frac{\partial z^m}{\partial w} \leq p^{-1}g_1(w-\xi)$.

When $x_i^c(k) = x_i(k,\delta)$, $x_i^c(k)$ is independent from w and therefore $x_i^c(w) = x_i^c(g(w-\xi;\psi))$ and $z_i^c(w)$ rises with w. Thus, opting out is optimal when

$$u(z_i^c(w);\phi) > u(z_i^c(g(w-\xi;\psi);\phi) > 0.$$

Because $g(w-\xi;\psi) - w > 0$ for all for all $w \in (w^{mc}, y^{mu} + \xi]$, this holds if and only if $w < w^{mc}$.

When $x_i^c(k) = x_i(k)$, $(x_i(k), z_i(k))$ rise with w. Thus, $(x_i(w), z_i^(w)) > (x_i(g(w-\xi;\psi)), z_i^(g(w-\xi;\psi)))$ if and only if $w < w^{mc}$. Thus, opting out is optimal whenever $w < w^{mc}$.

□

Proof of Proposition 5.

Lemma 3. *There exists threshold $\delta(k)$ such that $(x_i(k), z_i(k)) = (x_i^c(k), z_i^c(k))$ for all $\delta > \delta(k)$ and $(x_i(k), z_i(k)) = (x_i(k,\delta), z_i(k,\delta)$ for all $\delta \leq \delta(k)$. $\delta(k)$ rises with k.*

Proof of Lemma 3. Recall the first-order conditions

$$x_i : \sum_{j \neq i} f_1(x_i) - 1 + \mu_i(\delta \sum_{j \neq i} f_1(x_i) - 1) - \lambda_i = 0,$$
$$z_i : u_1(z_i; \phi) - p + \mu_i \delta(u_1(x_i; \phi) - p) - \lambda_i = 0$$

where λ_i is the Langrange multiplier for the resource constraint and $\mu_i \geq 0$ is the Lagrange multiplier for individual i's incentive compatibility constraint. Observe that $\lambda_i = (1 + \mu_i \delta)(u_1(z_i; \phi) - p) > 0$, whenever $z < z^{mu}$. Thus, whenever $w < w^{nmu}(\delta)$, the resource constraint binds. Let's denote the solution in this case by $(x_i^c(k), z_i^c(k))$ and observe that $x_i^c(k) = k_i - z_i^c(k)$.

Let's consider first the case in which $\mu = 0$ and therefore

$$x_i : \sum_{j \neq i} f_1(x_i) - 1 - \lambda_i = 0,$$
$$z_i : u_1(z_i; \phi) - p - \lambda_i = 0$$

In this case the solution will be given by the unique solution to $nf_1(x) - 1 = u_1(k - x; \psi) - p$, denoted by $x^{nm}(k)$ and $z^{nm}(k) = k - x(k)$. This is optimal if and only if the incentive-compatibility constraint is satisfied. This requires the following

$$x^{nm}(k) \leq \delta\Big(nf(x^{nm}(k)) + u(p^{-1}(k - x^{nm}(k)); \phi) - V^m\Big).$$

At $\delta = 0$, this inequality never holds, at $\delta = 1$, this holds since the RHS is larger than the LHS, otherwise the optimal will be to spend all the resources in market consumption, in which case the LHS and RHS will be zero. Thus, there exists a threshold $\delta(k)$ such that this solution is optimal whenever $\delta \geq \delta(k)$. Observe that $\delta(k)$ increases with k.

Let's denote the unique solution to

$$x = \delta\Big(nf(x) + u(p^{-1}(k - x); \phi) - V^m\Big)$$

by $(x(k, \delta), z(k, \delta))$, where $z(k, \delta) = k - z(k, \delta)$ and observe that

$$\mu_i = \frac{nf_1(x) - 1 - u_1(z; \phi) + p}{\delta(u_1(z; \phi) - nf_1(x)) + 1 - \delta p} > 0,$$

whenever $nf_1(x) - u_1(k - x; \phi) > 0$.

$$\frac{\partial x_i(k,\delta)}{\partial \delta} = \frac{nf(x_i) + u(z_i;\phi) - V^m}{\delta(u_1(z_i;\phi)p^{-1} - nf_1(x_i)) + 1} > 0.$$

Because $x_i(k)$ is independent of δ and $x_i(k) < x^{fb}$ since $u_1(z_i;\phi) > 1$ for all $z_i < z^{mu}$, there exists a threshold $\delta(k)$ such that $x_i(k) < x_i(k,\delta)$ for all $\delta > \delta(k)$.

Holding w constant, an change in k_i results in that

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

$z_i(k)$ increases with k, while an increase in w results in that

$$\frac{\partial x_i(k)}{\partial w} = \frac{u_{ii}}{nf_{ii} + u_{ii}} \frac{\partial k_i}{\partial w} \in (0,1)$$

$z_i(k)$ increases with w. Holding w constant, an change in k_i results in that

$$\frac{\partial x_i(k,\delta)}{\partial k_i} = \frac{\delta(u_1(z_i(k,\delta);\phi)p^{-1}}{\delta(u_1(z_i(k,\delta);\phi)p^{-1} - nf_1(x_i(k,\delta))) + 1} \geq 0,$$

and $z_i(k,\delta)$ increases with k, while an increase in w results in that

$$\frac{\partial x_i(k,\delta)}{\partial k_i} = \frac{\delta(u_1(z_i(k,\delta);\phi)p^{-1}\frac{\partial k_i}{\partial w} - V_w^m)}{\delta(u_1(z_i(k,\delta);\phi)p^{-1} - nf_1(x_i(k,\delta))) + 1} \geq 0,$$

where the inequality follows from $\frac{\partial k_i}{\partial w} = 1$ if $k_i = w$ and $\frac{\partial k_i}{\partial w} = g_1(w - \xi;\psi)$ if $k_i = g(w - \xi;\psi)$,

$$V_w^m = u_1(z;\phi)\frac{\partial z^m}{\partial w}|_{z=z^m} > 0.$$

where $\frac{\partial z^{mc}}{\partial w} = p^{-1}$ and $\frac{\partial z^m}{\partial w} = p^{-1}g_1(w - \xi;\psi) > 0$, $z^m \geq z_i(k,\delta)$. Thus, $z_i(k,\delta)$ increases with k.

This implies that $\delta(k)$ rises with k.

We deduce the result follows from this, Lemma 1, and the discussion on the main text.

□

Proof of Proposition 6. First, $w \geq w^{nmu}$ and $\delta \geq \delta^u$. Then, $x^{nm} = x^{fb}$ and $y^{nm} = y^{mu}$. Hence, $x_s^{nm} = 0$ for $s \in \{\phi, w, \xi, psi\}$ and $z_\phi^{nm} = 0$, $z_w^{nm} = z_\xi^{nm} = 0$, and $z_\phi^{nm} > 0$ since $u_{1\phi}(z;\phi) > 0$.

Next, let's assume that $w \geq w^{nmu}$ and $\delta < \delta^{nmu}$. Hence, $x^{nm} = x(\delta, z^{mu}, y^{mu})$ and $y^{nm} = y^{mu}$. Thus, for any $s \in \{\phi, \psi, \xi, w, \delta\}$,

$$\frac{\partial x^{nmu}}{\partial s} = \frac{1}{1 - \delta nf_1(x)} \frac{\partial \delta\big(nf(x^{nm}) + u(z^{mu};\phi) - pz^{mu} + g(y^{mu};\psi) - y^{mu} - \xi - V^m\big)}{\partial s}$$

Because $V^m = u(z^{mu}; \phi) - pz^{mu} + g(y^{mu}; \psi) - y^{mu} - \xi$, x^{nmu} is independent of (ϕ, ψ, ξ) and rises with δ. □

Proof of Proposition 7. First, consider the case $w \in [w^{nmb}, w^{nmu})$, In this case $(x^{nmc}, p^{-1}(w+g(y^{mu}; \psi) - y^{mu} - \xi - x^{nmc}), y^{mu})$.

If $\delta \geq \delta(w + g(y^{mu}; \psi) - y^{mu} - \xi)$, x^{nmc} satisfies the following

$$nf_1(x) - 1 - u_1(p^{-1}(w + g(y^{mu}; \psi) - y^{mu} - \xi - x^{nm}); \phi) + p = 0.$$

Thus, $z_s^{nm} > 0$ for all $s \in \{\phi, \psi, w\}$ and falls with ξ and $x_s^{nm} > 0$ for all $s \in \{\psi, w\}$ and falls with (ξ, ϕ) due the concavity of f and u.

If $\delta > \delta(w + g(y^{mu}; \psi) - y^{mu} - \xi)$, then x^{nmc} satisfies the following

$$x = \delta\big(nf(x) + u(p^{-1}(w + g(y^{mu}; \psi) - y^{mu} - \xi - x); \phi) - V^m\big)$$

Thus, for any $s \in \{\phi, \psi, \xi, w, \delta\}$,

$$\frac{\partial x^{nmc}}{\partial s} = \frac{1}{1 - \delta(nf_1(x) - u_1(z; \phi)p^{-1})} \frac{\partial \delta\big(nf(x) + u(p^{-1}(w + g(y^{mu}; \psi) - y^{mu} - \xi - x); \phi) - V^m\big)}{\partial s}.$$

Thus, x^{nmc} rises with δ and y^{nmc} falls with it. Because $w \geq w^{nmb} \equiv y^{mu} + \xi$ and $w^{nmb} = w^{mb}$, $V^m = u(p^{-1}(g(y^{mu}; \psi) + w - y^{mu} - \xi); \phi)$, $z^{nmc} < z^m$. This together with the concavity of u plus the complementarity between z and ϕ implies that x^{nmc} rises $\{\phi, w\}$ and falls with (ξ, ϕ) and z^{nmc} rises with $\{\phi, \psi, w\}$ and falls with ξ.

Second, consider the case $w \in [w^{nmc} w^{nmb})$. In this case $(x^{nmc}, p^{-1}(g(w - \xi; \psi) - x^{nmc}), w - \xi, 1)$.

If $\delta \geq \delta(g(w - \xi; \psi))$, x^{nmc} satisfies the following

$$nf_1(x) - 1 - u_1(p^{-1}(g(w - \xi; \phi) - x^{nm}); \phi) + p = 0.$$

Thus, $z_s^{nmc} > 0$ for all $s \in \{\phi, \psi, w\}$ and falls with ξ and $x_s^{nmc} > 0$ for all $s \in \{\psi, w\}$ and falls with (ξ, ϕ) due the concavity of f and u.

If $\delta < \delta(g(w - \xi; \psi))$, then x^{nmc} satisfies the following

$$x = \delta\big(nf(x) + u((g(w - \xi; \psi) - x)p^{-1}; \phi) - V^m\big)$$

Thus, for any $s \in \{\phi, \psi, \xi, w, \delta\}$,

$$\frac{\partial x^{nmc}}{\partial s} = \frac{1}{1 - \delta(nf_1(x) - u_1(z;\phi)p^{-1})} \frac{\partial \delta\big(nf(x^{nm}) + u(p^{-1}(g(w-\xi;\psi) - x^{nmc});\phi) - V^m\big)}{\partial s}$$

Thus, x^{nmc} rises with δ and y^{nmc} falls with it. Because $w \in [w^{nmc}, w^{nmb})$ and $w^{nmb} = w^{mb}$, $V^m = u(p^{-1}g(w-\xi;\psi);\phi)$, x^{nmc} is independent of (ϕ, ψ, ξ, w) and z^{nmc} rises with (ϕ, ψ, w) and falls with ξ.

Thus, $z_s^{nmc} > 0$ for all $s \in \{\phi, \psi, w\}$ and falls with ξ and $x_s^{nm} > 0$ for all $s \in \{\psi, w\}$ and falls with (ξ, ϕ) due the concavity of f and u. x^{nmc} is independent of (ϕ, ψ, ξ, w) and z^{nmc} rises with (ϕ, ψ, w) and falls with ξ.

□

Proof of Proposition 8. In this case $(x^{nmc}, p^{-1}(w - x^{nmc}), y^{mu})$.

If $\delta \geq \delta(w)$, x^{nmc} satisfies the following

$$nf_1(x) - 1 - u_1(p^{-1}(w - x^{nm});\phi) + p = 0.$$

Thus, $z_s^{nmc} > 0$ for all $s \in \{\phi, w\}$, falls with ξ, and is independent of ψ and x_s^{nm} rises with (w, ϕ), falls with ξ and is independent of ψ due the concavity of f and u.

If $\delta > \delta(w)$, then x^{nmc} satisfies the following

$$x = \delta\big(nf(x) + u(p^{-1}(w - x);\phi) - V^m\big)$$

Thus, for any $s \in \{\phi, \psi, \xi, w, \delta\}$,

$$\frac{\partial x^{nmc}}{\partial s} = \frac{1}{1 - \delta(nf_1(x) - u_1(z;\phi)p^{-1})} \frac{\partial \delta\big(nf(x) + u(p^{-1}(w-x);\phi) - V^m\big)}{\partial s}.$$

Thus, x^{nmc} rises with δ and y^{nmc} falls with it. Because $w < w^{nmc}$ and $w^{nmc} = w^{mc}$, $V^m = u(p^{-1}w;\phi)$, $z^{nmc} < z^m$. This together with the concavity of u plus the complementarity between z and ϕ implies that x^{nmc} rises $\{\phi, w\}$ and falls with (ξ, ϕ) and z^{nmc} rises with $\{\phi, \psi, w\}$ and falls with ξ.

□

Proof of Proposition 9. Recall that

$$V^{nm} = \begin{cases} nf(x^{nmu}) + u(z^{mu};\phi) - pz^{mu} + g(y^{mu};\psi) + w - y^{mu} - \xi & \text{if } w \geq w^{nmu}, \\ nf(x^{nmc}) + u(p^{-1}(w + g(y^{mu};\psi) - y^{mu} - \xi - x^{nmc});\phi) & \text{if } w \in [w^{nmb}, w^{nmu}), \\ nf(x^{nmc}) + u(p^{-1}(g(w-\xi;\psi) - x^{nmc});\phi) & \text{if } w \in [w^{nmc}, w^{nmb}), \\ nf(x^{nmc}) + u(p^{-1}(w - x^{nmc});\phi) & \text{if } w \in [0, w^{nmc}). \end{cases}$$

When $w \geq w^{nmu}$ and $\delta \geq \delta^{mnu}$, the result follows from the envelope theorem and the fact that $u_\phi(z^{mu};\phi) > 0$, $g_\psi(y^{mu};\psi) > 0$ and welfare, ceteris-paribus, rises with $w - \xi$. In contrast when $\delta < \delta^{mnu}$

When $w < w^{nmu}$ and $\delta \geq \delta^{mnc}$, the result follows again from the envelope theorem and the fact that $u_\phi(z^{mu};\phi) > 0$, $g_\psi(y^{mu};\psi) > 0$ and welfare, ceteris-paribus, rises with $w - \xi$.

Observe that for all $w < w^{nmu}$, $V^{nm} - V^n$ rises with w if and only if

$$nf_1(x^{nmc})\frac{\partial x^{nmc}}{\partial w} + u(p^{-1}(w + m(g(y^{nmc};\psi) - y^{nmc} - \xi) - x^{nmc});\phi)\times$$
$$p^{-1}\Big(1 + \frac{\partial m(g(y^{nmc};\psi) - y^{nmc})}{\partial w} - \frac{\partial x^{nmc}}{\partial w}\Big)nf_1(x^n)\frac{\partial x^n}{\partial w}.$$

In Propositions 7 and 8, we show that $\frac{\partial x^{nmc}}{\partial w} \in (0,1)$, $1 + \frac{\partial m(g(y^{nmc};\psi)-y^{nmc})}{\partial w} = 1$ if $w < w^{nmc}$, and $1 + \frac{\partial m(g(y^{nmc};\psi)-y^{nmc})}{\partial w} = g_1(w-\xi;\psi) > 1$ if $w \in [w^{nmc}, w^{nmb})$, and $1 + \frac{\partial m(g(y^{nmc};\psi)-y^{nmc})}{\partial w} = 1$ if $w \in [w^{nmb}, w^{nmu})$.

Taking the limit as w goes to zero to both sides of the equation, noticing that $\lim_{w\to 0}\frac{\partial x^{nmc}}{\partial w} \to 0$ and $u(p^{-1}(0;\phi)p^{-1} < nf_1(0)$.

Observe also that $\lim_{w\to 0}(V^{nm} - V^n) \to 0$ and $\lim_{w\to w^{nmu}}(V^{nm} - V^n) > 0$. By the Intermediate-value theorem, this, together with the result above and the fact that $V^{nm} - V^n$ is continuous in w, implies there exists a threshold $w^* \in (0, w^{nmu})$, such that $V^{nm} > V^n$ for all $w > w^*$,

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. □