Common beliefs and welfare: opposite beliefs can share a similar result*

Sebastián Cea-Echenique†

Alejandra Marinovic

April 29, 2020.

Abstract

In a competitive setup, agents decide whether to participate in a productive interaction and, if participating, whether to choose a high-output payoff with a utility cost or less payoff without the cost. Examples of this situation are effort, cooperation and trust choices. Matching in the interaction is anonymous. Maximizing expected utility requires agents to forecast the endogenous distribution of agents' actions in society. There is an exogenous multiplicity of equilibria induced by the quantity of actions that characterize the interaction and common beliefs configuration requiring self-fulfilling beliefs. The equilibria are Pareto rankable, which permits a concrete characterization of the relation between beliefs and

*This is part of Cea-Echenique's Ph.D. dissertation at Université Paris 1 Panthéon Sorbonne. Previous version of this manuscript circulated with the title "Trust does not necessarily improve efficiency". We appreciate the valuable comments of Antoine Billot, Jean-Marc Bonnisseau, Bernard Cornet, Etienne de Villemeur, Benedetto Gui, Carlos Hervés-Beloso, Daniel Hojman, Rodrigo Mardones, Nicholas Yannelis, the participants in the SWET 2016 conference, University Paris 2 Seminar, Chilean Economics Society 2013 meeting and Adolfo Ibañez University Seminar, and a useful conversation with William Zame. Cea-Echenique acknowledges financial support from Conicyt through Fondecyt Project 3170689. An interactive visualization of the data presented in the paper is available at `https://sebacea.shinyapps.io/CommonBeliefs/`.

†Corresponding author. *Address*: School of Industrial Engineering, Pontificia Universidad Católica de Valparaíso, Brasil 2241, Oficina 5-8, Valparaíso, Chile. *Phone*: +56322273607. *E-mail address*: `sebastian.cea@pucv.cl`

welfare through parametrizing economies by the payoffs of the interaction. For instance, it is possible for an economy to reach two different equilibria with equal welfare and different beliefs. Thus, this study contributes, from a theoretical perspective, to explaining dispersion in beliefs for a given welfare measure. We contrast our theoretical results with empirical measures of welfare and beliefs from the World Values Survey.

JEL Classification. D71, D61, D50, C72

Keywords. Efficiency, Generalized trust, Welfare

1 Introduction

Beliefs with respect to others' behavior have been included in a wide variety of surveys in recent years, elicited through the degree of agreement with a sentence or a dilemma. Perhaps the most well-known is "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?" that is used in the World Values Survey (WVS) and other polls.[1] Another example recently included in the WVS is the answer to the question "Do you think most people would try to take advantage of you if they got a chance, or would they try to be fair?". The ideas related to such measures have been analyzed from diverse perspectives, including economics, sociology and political science.

The interest in quantitative measures that reflect beliefs is fostered by numerous indications of their social relevance: more optimistic or benevolent measures are correlated with higher levels of development, life satisfaction, equity and/or efficiency (see Knack and Keefer [1997] and more recently Mikucka et al. [2017]). The difficulty of deriving a precise conceptual definition of such measures offers considerable opportunity for explaining mechanisms that link expectations to welfare.

In theoretical works, a belief regarding trust is studied through strategic frameworks but without constructing an aggregated trust measure built from individuals' beliefs (Glaeser et al.

[1] www.worldvaluessurvey.org. For the Americas, these surveys include the Latin American Public Opinion Project (LAPOP) (www.vanderbilt.edu/lapop/index.php) and Latinobarómetro for Latin America (www.latinobarometro.org). For Asia, see www.asiabarometer.org, and for Africa, see www.afrobarometer.org; although we do not have a corresponding question to the WVS trust question (see Buzasi [2015]). The validity of the WVS trust question has been the matter of several studies including Glaeser et al. [2000], Johnson and Mislin [2012], Sturgis and Smith [2010], Uslaner [2011].

[2000]). Zak and Knack [2001] elaborate on a competitive economy that features strategic interaction between consumers and investment brokers. Their model includes an explicit relation between the economy's trust level and individual choices of time dedicated to an *investment investigation technology*, also called *diligence*. Thus, the trust level is the amount of time in the society not allocated to verifying others' actions. In this general framework with heterogeneous agents, the authors prove that inequality in wages reduces the level of trust.

The present work presents a competitive economy used to explore the relationship between beliefs and welfare in the context of anonymous interactions and preferences carrying a cost associated with productivity. No inequality is introduced into the configuration to concentrate the argument on beliefs. As Thöni et al. [2012] note, perfect anonymity and a one-shot nature are apt to capture beliefs regarding a *generalized other*, e.g., *thin* trust, in contrast to beliefs in repeated interaction within a social network, e.g., *thick* trust. We show that expectations concentrated on the realization of the most productive behavior do not necessarily imply higher welfare.

Nevertheless, greater expectations regarding the productive action are— generically with respect to the parameter space—associated with an efficiency gain due to increased production and cheaper consumption. We focus on a simple model that, without agent heterogeneity or temporal dynamics, provides a clean mechanism connecting beliefs and welfare and the resulting impact on efficiency.

We offer an empirical motivation in the following subsection. Then, we describe the model in Section 2. We parametrize a family of economies and characterize equilibria in Section 3. We discuss applications of our results in Section 4, which are in line with the empirical motivation we provide. Section 5 concludes the paper. Proofs are provided in the appendix.

1.1 Empirical motivation: Trust and fairness dispersion for equal life satisfaction

Differences in beliefs and outcomes have already been analyzed with a multiple-equilibria configuration. For instance, Alesina and Angeletos [2005] motivate their model with differences in beliefs; luck determines income where equilibrium choices reflect different policies. We parallel their argument by trying to understand how multiple equilibria can explain belief differences

Figure 1: Trust and Life Satisfaction across WVS Waves 5 and 6 (2005-2014). Proportion of people answering “most people can be trusted” to the question: Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?

for a given welfare level. Nevertheless, since our focus is on welfare, we introduce a strategic interaction into the configuration to link beliefs and specific behaviors. Thus, multiplicity is generated by the number of behaviors in the strategic interaction instead of the distributions of the characteristics of the economy.

Empirical evidence indicates that generalized trust significantly explains welfare measures such as life satisfaction; see Bjørnskov [2003] or Bartolini et al. [2017]. Moreover, recent findings report that questions such as trust in the WVS are mostly related to agents’ beliefs (see Sapienza et al. [2013]). Figure 1 presents data from the WVS 2005-2014 waves between the typical trust question, as presented above, and the proportion of people who reported life satisfaction level to be higher than six (where one means “completely dissatisfied” and ten “completely satisfied”).

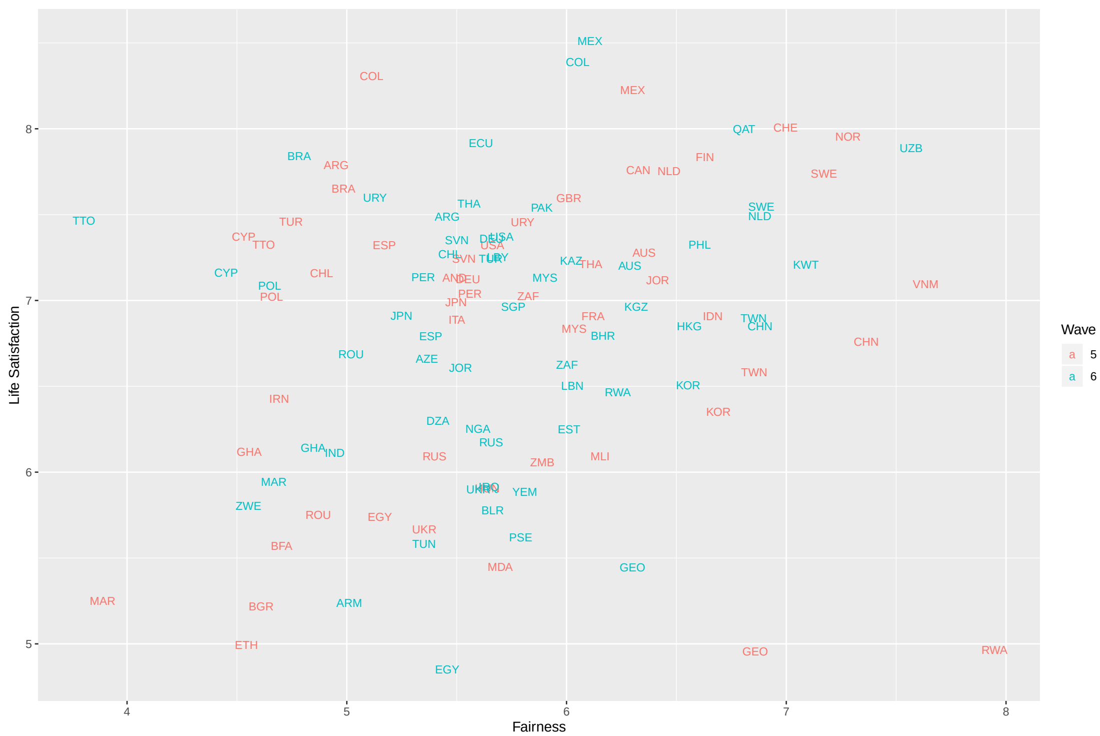

Figure 2: Fairness and Life Satisfaction across WVS Waves 5 and 6 (2005-2014). Average answer on the Likert scale to the question: Do you think most people would try to take advantage of you if they got a chance, or would they try to be fair?

Additionally, Figure 2 contains fairness data (where one means that “people would try to take advantage of you” and ten “people would try to be fair”). A simple correlation shows a positive relation across both beliefs about trust and fairness with respect to life satisfaction. Nevertheless, for a given welfare level, there are significant differences in beliefs among countries. Therefore, our aim is to provide an equilibrium argument to rationalize these outcomes.

2 Model

Our model follows Zame [2007], a broad general equilibrium model of endogenous firm formation. We use a particular case of this configuration with a unique 2-person (2-role) interaction that explicitly considers incentives to choose an action between two possibilities. This setup offers three essential elements to our modeling: (i) it provides a visible role for beliefs through expected utilities in equilibrium; (ii) it offers the possibility of Pareto ranking the outcomes; and (iii) the framework focuses on anonymous random interactions where participation is endogenous, as our interest is centered on beliefs towards a *generalized other*.

The model is characterized by two perfectly divisible commodities traded on competitive markets. There are many identical agents in terms of preferences and endowments of the two commodities. The economy is endowed only with the first commodity: an agent's endowment is $e = (1, 0)$. The second commodity is produced through interaction using the first commodity. Individuals decide whether to participate in this interaction, and if participating, there are two available actions denoted by a for each of the two symmetric roles $r \in \{r_1, r_2\}$: the *high* action (H) or the low action (L); thus, $a \in \{H, L\}$.[2] Hence, the set of available actions is $\mathbb{F} := \{(r, a) \in \{r_1, r_2\} \times \{H, L\}\} \cup \{0\}$, where 0 denotes not participating and a typical element $\phi \in \mathbb{F}$ is decomposed by $\phi = (\phi_r, \phi_a) \in \{r_1, r_2\} \times \{H, L\}$ if $\phi \neq 0$.

To participate, each agent must invest her endowment of the first commodity to receive commodity 2. Given an anonymous matching of two individuals willing to participate in the interaction, there are 3 possible consequences: a good outcome (g), obtained when both agents choose H; a bad outcome (b), which arises if both agents choose L; and a medium outcome (m), when agents' actions are different.

Define the set of consequences of the interaction by $\Omega = \{g, m, b\}$: the quantity of commodity 2 resulting from the interaction varies according to the actions taken by the agents involved and is denoted by $2C_\omega$ for $\omega \in \Omega$. Output is observable and contractible, but actions are not. Since roles in the interaction are symmetric and each participant provides half the input, the associated individual real payoff is half the output, i.e., C_ω.[3] For the sake of notation, the *per capita* technology of the interaction is denoted by $y(\omega) = (-1, C_\omega)$ for each $\omega \in \Omega$. Accordingly, $C_g \geq C_m \geq C_b$.

[2]The literal interpretation provided in Zame [2007] refers to high or low effort. We would like to provide the interpretation in terms of trust in line with evidence of a link between trust and productivity (Bjørnskov and Méon [2015]). Another example would be a choice regarding cooperation. In the presentation of the model, we focus on the general meaning with respect to a high or low output/action.

[3]Note that a comparison of this generalized trust interaction with the classical trust game is not direct: here, we consider a one-shot interaction in contrast to the sequential framework usually adopted. In both cases, trustful agents are exposed to losses if betrayed.

Since roles in the interaction are filled by agents choosing $\mathbf{a} = (a_1, a_2) \in A := \{H, L\} \times \{H, L\}$, conditional probabilities are characterized by the function $\pi : A \to \mathcal{P}(\Omega)$, where a mapping $\mathcal{P}$ defines the space of probability measures over the argument under the natural algebra. Therefore, given $\mathbf{a}$, the probability that state $\omega \in \Omega$ occurs is $\pi(\omega|\mathbf{a})$. For notational purposes, take $\mathbf{a}_{-r}$ equal to $a_{r'}$ such that $r' \neq r$ for $r' \in \{r_1, r_2\}$. Given $\phi \in \mathbb{F}$, we abuse notation by writing $(\phi_a, \mathbf{a}_{-\phi_a})$ when ϕ_r is r_1 or r_2.[4] In addition, we assume that the matching of agents in each interaction is random and uniform.

A consumption decision, $\tilde{x}$, is a random variable that associates to each consequence $\omega \in \Omega$ a bundle of consumption $(x_1, x_2) \in \mathbb{R}^2_+$. However, since not participating in the interaction is always an option, feasible consumption of an agent whose strategy is not to interact should be independent of possible consequences. Thus, the choice set is defined by

$$X := \{(\tilde{x}, \phi) \in \mathbb{R}^{2|\Omega|} \times \mathbb{F} : \phi = 0 \quad \text{requires} \quad \tilde{x}(g) = \tilde{x}(m) = \tilde{x}(b)\}.$$

We normalize commodity prices with respect to good one such that the price of good two is denoted by $q \in \mathbb{R}_{++}$. Therefore, $(\tilde{x}, \phi) \in X$ is budget feasible at consumption prices $p = (1, q)$ if for each $\omega \in \Omega$, we have $p \cdot \tilde{x}(\omega) \leq p \cdot e + p \cdot y(\omega)\mathbf{1}_{\phi \neq 0}$, where $\mathbf{1}_{\phi \neq 0}$ is the indicator function of condition $\phi \neq 0$. At given prices p, the set of budget-feasible vectors is denoted by $B(p)$.

Agents have preferences over consumption vectors given the action they take with respect to the interaction. Thus, there is a utility function $u : \mathbb{R}^2_+ \times \mathbb{F} \to \mathbb{R}$. Let β denote a probability measure on A that represents agents' beliefs. Agents are interested in maximizing the expected utility of their plan $(\tilde{x}, \phi) \in B(p)$ with respect to the conditional probability $\pi(\mathbf{a})$ and beliefs β. For this, define

$$\pi(\omega|\phi, \mathbf{a}) = \begin{cases} \pi(\omega|(\phi_a, \mathbf{a}_{-\phi_r})) & \text{if} \quad \phi \neq 0 \\ \pi(\omega|\mathbf{a}) & \text{if} \quad \phi = 0 \end{cases}$$

That is, expected utility is given by

$$\mathbb{E}[u(\tilde{x}, \phi)|\beta] = \sum_{\mathbf{a} \in A} u(\tilde{x}(\omega), \phi)\pi(\omega|\phi, \mathbf{a})\beta(\mathbf{a}).$$

An equilibrium concept in this configuration requires agents to not regret ex ante decisions. Otherwise, ex post actions may not be optimal. Therefore, we concentrate on beliefs that are

[4] For instance, if $\phi_r = r_2$, then the vector should read $(\mathbf{a}_{-\phi_a}, \phi_a)$

shared across the population, i.e., common beliefs. To obtain a proof of existence and further discussion of this model, we refer to Zame [2007].

Intuitively, given that the economy is endowed only with units of good 1 and that the interaction requires good 1 as input, then equilibria share a particular property. Specifically, if every agent participates in the interaction, there are no units of good 1 left to consume. Conversely, if no agents participate in the interaction, there are no units of good 2 in the economy. That is, if agents need to consume at least some amount of each good to have a non-zero utility, then in equilibrium, we should have some agents who participate in the interaction and some who do not. The following definition restricts attention to those configurations that are the focus of our study in the following section.

Definition 1. A probability measure μ on $\mathbb{R}^{2|\Omega|} \times \mathbb{F}$ is consistent if

$$0 < \mu(\{(\tilde{x}, \phi) : \phi_r = r_1\}) = \mu(\{(\tilde{x}, \phi) : \phi_r = r_2\}) < 1.$$

Note that a consistent probability satisfies $\mu(\{(\tilde{x}, \phi) : \phi \neq 0\}) \neq 0$. Let μ be a consistent probability measure on $\mathbb{R}^{2|\Omega|} \times \mathbb{F}$; define the probability that action (a_1, a_2) is taken in the interaction conditional on the consistent probability by

$$\gamma((a_1, a_2)|\mu) = \frac{\mu(\{(\tilde{x}, \phi) : \phi = (r_1, a_1)\}) + \mu(\{(\tilde{x}, \phi) : \phi = (r_2, a_2)\})}{\mu(\{(\tilde{x}, \phi) : \phi \neq 0\})}.$$

Consequently, the probability that outcome $\omega \in \Omega$ occurs conditional on μ is given by $\Gamma(\omega|\mu) = \sum_{(a_1,a_2)\in A} \pi(\omega|(a_1, a_2))\gamma((a_1, a_2)|\mu)$. Therefore, aggregate production can be written as follows:

$$Y(\mu) := \frac{\mu(\{(\tilde{x}, \phi) : \phi \neq 0\})}{2} \sum_{\omega\in\Omega} y(\omega)\Gamma(\omega|\mu).$$

To define aggregate consumption, let $\gamma_\phi(\mathbf{a}|\mu) = \gamma((\phi_a, \mathbf{a}_{-\phi_a})|\mu)$, and denote the sets of agents following a particular action ϕ and the set of strategies available to other players by, respectively,

$$K(\phi) = \{(\tilde{x}, \psi) \in \mathbb{R}^{2|\Omega|} \times \mathbb{F} : \psi = \phi\} \quad \text{and} \quad \Lambda(\phi) = \begin{cases} A & \phi = 0 \\ \{H, L\} & \phi \neq 0 \end{cases}.$$

Thus, provided a consistent probability μ, we can specify a probability distribution over actions. Furthermore, for this conditional distribution of actions, we can obtain the expectation of consumption by taking the probability π over the states in Ω. This gives a definition of aggregate consumption as follows:

$$X(\mu) = \sum_{\phi\in\mathbb{F}} \int_{K(\phi)} \sum_{\omega\in\Omega} \int_{\Lambda(\phi)} \tilde{x}(\omega)\pi(\omega|(\phi_r, \mathbf{a}_{-\phi_r}))d\gamma_\phi(\mathbf{a}|\mu)d\mu.$$

We now have all the necessary constructions to define the equilibrium concept.

Definition 2. A common beliefs equilibrium of the economy is given by a tuple $(\overline{q}, \overline{\beta}, \overline{\mu}) \in \mathbb{R}^2_+ \times \mathcal{P}(A) \times \mathcal{P}(\mathbb{R}^{2|\Omega|} \times \mathbb{F})$ such that:

1. $\overline{\mu}$ is consistent and such that: (a) $\overline{\mu}(\{(\tilde{x}, \phi) : (\tilde{x}, \phi) \notin X\}) = 0$ and (b) $X(\overline{\mu}) = Y(\overline{\mu}) + (1, 0)$
2. Individual budget feasibility: $\overline{\mu}(\{(\tilde{x}, \phi) : (\tilde{x}, \phi) \notin B(p)\}) = 0$
3. Optimality: $\overline{\mu}(\{(\tilde{x}, \phi) : \exists(\tilde{x}', \phi') \in X \cap B(p), \mathbb{E}[u(\tilde{x}', \phi')|\beta] > \mathbb{E}[u(\tilde{x}, \phi)|\beta]\}) = 0$
4. Correct beliefs: $\overline{\beta} = \gamma(\cdot|\overline{\mu})$.

3 Parametrization of the economy

Having defined the equilibrium concept, we focus on a family of economies parametrized by medium output for a given utility function presenting a cost with respect to the choice of the high-output action.

Definition 3. Utility function $u : \mathbb{R}^2_+ \times \mathbb{F} \to \mathbb{R}$ exhibits a high action cost if $u(\cdot, H) \leq u(\cdot, L)$.

Assume that $C_g = 2$, $C_b = 1$. Consider a family of economies parametrized by medium output $C_m \in [1, 2]$, and denote such a family by $\mathcal{E}(C_m)$. Preferences exhibit a high action cost depending on the possible output loss.[5]

$$u(x_1, x_2, \phi, C_m) = \begin{cases} T\left(\sqrt{x_1 x_2}, C_m\right) & \text{if} \quad \phi_a = H \\ \sqrt{x_1 x_2} & \text{otherwise,} \end{cases}$$

where $T(t, C_m) = \begin{cases} \frac{C_m}{2} \cdot t & \text{if} \quad t \in \left[0, \frac{1}{\sqrt{C_m}}\right] \\ \frac{\sqrt{C_m}}{2} + \frac{1}{15}\left(t - \frac{1}{\sqrt{C_m}}\right) & \text{if} \quad t \in \left[\frac{1}{\sqrt{C_m}}, +\infty\right[. \end{cases}$

[5] This family of economies is a parametrization with respect the medium output of Example 7 in Zame [2007].

Our first result characterizes equilibria of the economies in $\mathcal{E}(C_m)$.

PROPOSITION 1. *There are two equilibria for each economy in $\mathcal{E}(C_m)$. In particular, in one equilibrium ("high output"), all agents participating in the interaction choose H and are in proportion $\frac{C_m}{2+C_m}$. In the other equilibrium ("low output"), all agents in the interactions choose L, and participation is in proportion* 0.5.

Welfare levels in the optima can be characterized in terms of parameter C_m (see Table 1). When the high-output equilibrium is considered, i.e., beliefs are given by $\beta((H,H)) = 1$, the welfare levels depending on actions are given in Panel (A) of Table 1. The results on the upper left provide the equilibrium welfare $\sqrt{C_m}/2$ when both interacting agents choose H. In fact, it is possible to verify that this welfare level dominates any deviation, e.g., where the row player chooses L with welfare $\sqrt{C_m}/2$ and the column player has $C_m^{\frac{3}{2}}/4$. In addition, the action not to participate is given by the zero row, and welfare $\sqrt{C_m}/2$.

Table 1: Welfare dependence on action and medium output for row player

(A) For equilibrium price and beliefs $(\overline{q}, \overline{\beta}((H,H))) = \left(\frac{1}{C_m}, 1\right)$

	H	L
H	$\frac{\sqrt{C_m}}{2}$	$\frac{C_m^{\frac{3}{2}}}{4}$
L	$\frac{\sqrt{C_m}}{2}$	$\frac{1}{2\sqrt{C_m}}$
0	$\frac{\sqrt{C_m}}{2}$	

(B) For equilibrium price and beliefs $(\overline{q}, \overline{\beta}((L,L)) = (1,1)$

	H	L
H	$\frac{\sqrt{C_m}}{2} + \frac{1}{15\sqrt{C_m}}(\sqrt{C_m} - 1)$	$\frac{C_m^2}{4}$ *
L	$\frac{C_m}{2}$	$\frac{1}{2}$
0	$\frac{1}{2}$	

*: Welfare level $C_m^2/4$ represents $T(C_m/2)$ when $C_m \leq 1.59$; otherwise $T(C_m/2) = \sqrt{C_m}/2 + (1/15)(C_m/2 - 1/\sqrt{C_m})$

Similarly, when the low-output equilibrium is considered, i.e., beliefs are $\beta((L,L)) = 1$, the welfare levels are shown in Panel (B) of Table 1. Contrary to the high-output equilibrium, here a joint deviation to H is profitable. Nevertheless, $C_m/2$ dominates the welfare level from deviating, and therefore, the deviation is not self-enforcing.

3.1 Beliefs, efficiency and welfare

Note that differences between C_g and C_m only affect welfare in the high-output equilibrium.

PROPOSITION 2. *For economies $\mathcal{E}(C_m)$ with $C_m \in (1,2]$ and beliefs $\beta((H,H)) = 1$, a higher C_m induces greater welfare and a larger proportion of people interacting.*

For $C_m \in [1,2]$, denote $\overline{u}_H(C_m)$ as the welfare level in equilibrium when beliefs are $\beta((H,H)) = 1$ and as $\overline{u}_L(C_m)$ when beliefs are $\beta((L,L)) = 1$. Similarly, let $\overline{\mu}_H = \mu(\{(\tilde{x},\phi) : \phi_a = H\})$ in equilibrium when beliefs are $\beta((H,H)) = 1$ and $\overline{\mu}_L = \mu(\{(\tilde{x},\phi) : \phi_a = L\})$ when beliefs are $\beta((L,L)) = 1$. The following figure provides a visualization of the relation between welfare and parameter C_m. Specifically, a smaller distance between the medium and the good output induces a larger welfare gap between equilibria; that is, a larger efficiency gain.

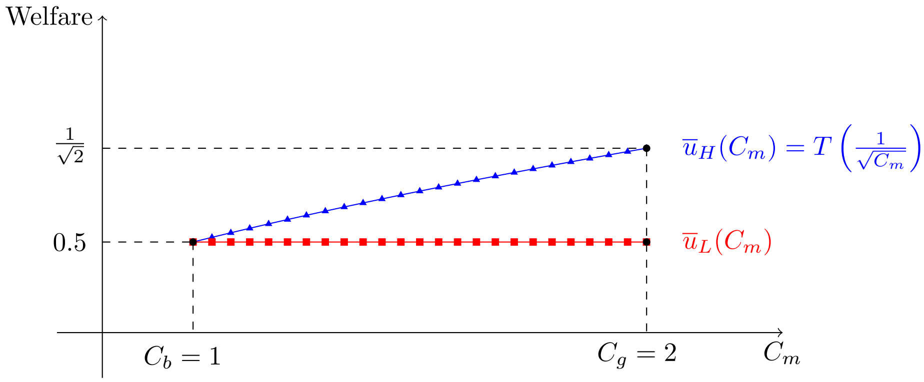

Figure 3: Welfare and parameter C_m.

When the medium output converges to the highest output, welfare increases because a larger proportion of agents produce more of commodity two and the price is lower.

REMARK 3.1. *For economies $\mathcal{E}(C_m)$ with $C_m \in (1,2]$, equilibria are Pareto rankeable, and in particular, the equilibrium with beliefs $\beta((H,H)) = 1$ is a strict Pareto improvement with respect to the equilibrium with $\beta((L,L)) = 1$.*

To explore the relation between beliefs and welfare in the model, let us define the following measure.

Definition 4. For a given equilibrium $(\overline{q}, \overline{\beta}, \overline{\mu})$, a measure of the belief about other people's behavior (OPB belief) is provided by proportion $\overline{\mu}(\{(\tilde{x}, \phi) : \phi_a = H\})$.

Note that considering OPB beliefs is consistent with recent literature regarding beliefs in strategic interactions, such as in the case of a trust game. In particular, see Sapienza et al. [2013].

For the high-output equilibrium, the measure defined above (Definition 4) is a monotonic transformation of $C_m \in (1, 2]$, and hence it is positively associated with the level of welfare. Furthermore, provided that the parameter space is $[1, 2]$, the property is valid for an open and dense set (the open real interval $(1, 2)$), ensuring genericity with respect to the parameter space.

Conversely, we note a particular case that appears counterintuitive: it is not possible to ensure the monotonicity property in all cases.

Proposition 3. *If OPB belief increases, then welfare does not necessarily increase.*

Indeed, we highlight a parameterization where there is no welfare improvement between equilibria. When medium output decreases, fewer people participate in the interaction, and the second good becomes more scarce. This implies that the price is higher, inducing a welfare loss (see Figures 4 and 5).

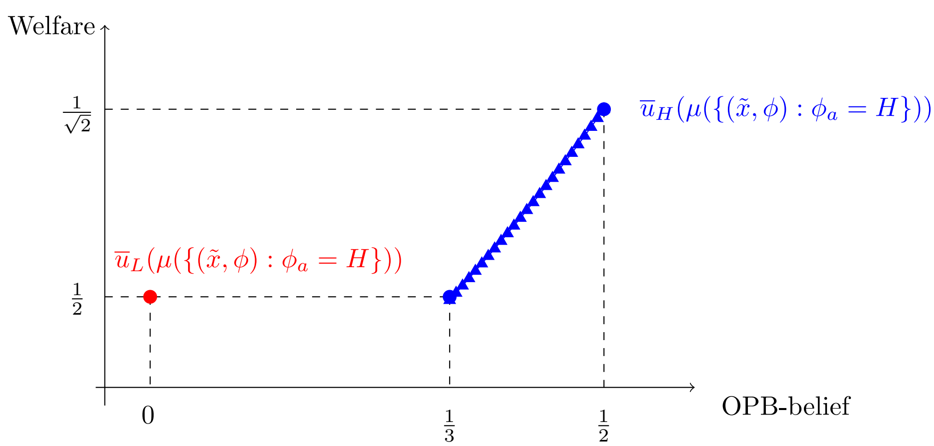

Figure 4: Relation between welfare and OPB belief when $C_m \in [1, 2]$, $C_b = 1$ and $C_g = 2$.

The welfare in the high-output equilibrium is bounded below by the welfare of the low-output equilibrium. In fact, welfare in the high-output equilibrium decreases as the relative

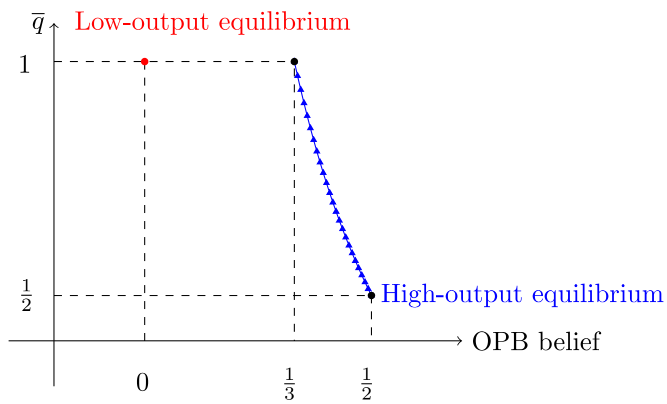

Figure 5: Relation between the equilibrium price and OPB belief when $\beta((H, H)) = 1$.

price increases and approaches the equilibrium price of the low-output equilibrium.

In the following subsection, we discuss a more general parametrization that maintains the validity of the results.

3.2 General parametrization

Consider the family of economies parametrized by $(m_1, m_2, C_b, C_m, C_g) \in (0,1) \times (0,1) \times \mathbb{R}_+ \times \mathbb{R}_+ \times \mathbb{R}_+$, denoted $\mathcal{E}(m_1, m_2, C_b, C_m, C_g)$ such that the utility function is given by

$$u(x_1, x_2, \phi, m_1, m_2, C_g) \quad = \quad \begin{cases} T\left(\sqrt{x_1 x_2}, m_1, m_2, C_g\right) & \text{if} \quad \phi_a = H \\ \sqrt{x_1 x_2} & \text{otherwise,} \end{cases}$$

$$\text{where } T(t, m_1, m_2, C_g) = \begin{cases} m_1 \cdot t & \text{if} \quad t \in \left[0, \frac{1}{2}\sqrt{\frac{C_g}{m_1}}\right] \\ m_1 \cdot \frac{1}{2}\sqrt{\frac{C_g}{m_1}} + m_2 \left(t - \frac{1}{2}\sqrt{\frac{C_g}{m_1}}\right) & \text{if} \quad t \in \left[\frac{1}{2}\sqrt{\frac{C_g}{m_1}}, +\infty\right[. \end{cases}$$

In this configuration, we are able to summarize the results provided in the preceding section.

Proposition 4. *There are two equilibria for each economy in $\mathcal{E}(m_1, m_2, C_b, C_m, C_g)$. In particular, in one equilibrium, proportion $\frac{m_1}{1+m_1}$ participates in the interactions, and all of them choose H. In the other equilibrium, all agents in the interactions* *choose L, and participation is in proportion* 0.5*. Moreover, welfare in the equilibrium where all participating agents choose H is equal to or higher than the welfare in the other equilibrium.*

This proposition generalizes the result provided in Proposition 1 and Remark 3.1. In fact, the results given in Section 3.1 remain valid for any general parametrization. Moreover, the case in which both equilibria (high and low) exhibit the same level of welfare is not only a single point in this more general parametrization, given the condition in the following remark.

REMARK 3.2. *The family $\mathcal{E}(m_1, m_2, C_b, C_m, C_g)$ where $m_1 = C_b/C_g$ contains economies with equal-welfare but different OPB beliefs across equilibria for each parametrization.*

This remark provides a general condition that supports the result given in Proposition 3.

4 Applications

We motivate the analysis with some well-known survey measures of beliefs. Here, we would like to make some remarks.

4.1 Trust

The definition of trust exhibits significant complexities. Nannestad [2008] considers two main dimensions of trust. The first distinguishes whether trust is rational or guided by norms (normative). Rational or strategic trust supposes the use of logic and the analysis of causes and consequences, while normative trust regards what is considered proper. The second dimension distinguishes generalized and particularized trust. At one extreme, there is trust in a specific individual (interpersonal trust) in relation to a particular situation, and at the opposite extreme, there is trust in unknown persons with respect to unspecified topics (Nannestad [2008], 414). [6]

The OPB belief (Definition 4) regards expectations of other people choosing the high-output action. Note that in the interaction described in our model, the consequence of choosing action

[6] Some view trust at the essence of social interactions. For instance, it is a fundamental concept of the Neapolitan School, started by Antonio Genovesi (1713-1769), and it is considered as a necessary condition for economic success (Bruni and Sugden [2008], Hardin [2002], 188). Durlauf and Fafchamps [2005], on the other hand, point out that even if trust is constitutive of social capital, which fosters economic performance, it is an instrument to mitigate market imperfections that hinder the attainment of optimal results.

H is a gain in output at a cost to utility. Analogously, choosing a "trust" action carries an output gain from efficiency, e.g., less monitoring, and a cost associated with betrayal risk. Our interpretation of OPB beliefs as trust follows the definition given by Buzasi [2015]: "expectations about the risk of engaging in an interaction with someone else".[7] Accordingly, the application of the results of this study refers to rational generalized trust.

By reading action H as trust, the model provides an explanation for the positive relation among generalized trust, efficiency and welfare. Indeed, Proposition 2 supports the literature regarding the link between trust and development.[8] Note that this application relates directly to the WVS question about generalized trust (see Figure 1).

4.2 Fairness

The nature of our configuration assumes equal division of the output generated in the interaction. Thus, there is an exogenous and equal division of the outcome of such interaction. This interpretation could prevent the study of fairness in our model for a given equilibrium. However, for a given parametrization, two different equilibria are given. With respect to that, another characterization of fairness states that an outcome is said to be fair if no individual in the society prefers the outcome of another (Pazner and Schmeidler [1974]). From that perspective, agents differ in the action taken across equilibria for a given parametrization. In other words, to be fair is understood as choosing a high-output behavior. Otherwise, in the low-output equilibrium, agents envy the outcome of the high-output equilibrium.

4.3 Welfare invariance in data

Proposition 3 points out that a specific parametrization could provide an explanation for the horizontal dispersion observed in Figures 1 and 2. However, the dispersion observed confounds different parameterizations of our model. Therefore, we have to concentrate on comparable parameterizations, i.e., countries. Thus, for similar welfare outcomes, we should observe similar belief outcomes up to an specific point of the parametrization. Otherwise, for that specific point, we have that similar welfare outcomes are associated with different belief outcomes. The

[7] This is in line with Rousseau et al. [1998] and Sapienza et al. [2013].

[8] For instance, see Beugelsdijk et al. [2004], Guiso et al. [2004], Zak and Knack [2001].

occurrence of this appears to be more an exception than a rule, and we would like to contrast these facts with the data.

Figure 6: Trust and Life Satisfaction across WVS Waves 5 and 6 (2005-2014). Subset of countries where Life Satisfaction does not significantly change across waves.

We conduct an exploratory exercise by computing confidence intervals of life satisfaction for each country and wave of the WVS. When confidence intervals intersect across waves, we say that life satisfaction is not significantly different on a subset of 19 countries (Figures 6 and 7) that represent the 27.9% in the sample of countries with data in both waves.

For this subset, we perform a classification regarding changes in trust and fairness measures across waves. Thus, with confidence intervals of each measure, we classify the countries between those with beliefs that are statistically different on trust (5 countries or 26.3% of the sub-sample) and fairness (9 countries or 47.4%). Surprisingly, the dispersion of beliefs for a statistically invariant welfare measure seems to be a less an exception. That is, these gaps of beliefs (9% for trust and 5.8% for fairness) should be regarded as traps for welfare improvements. Further analysis should be conducted in this direction to characterize other components explaining these differences in beliefs.

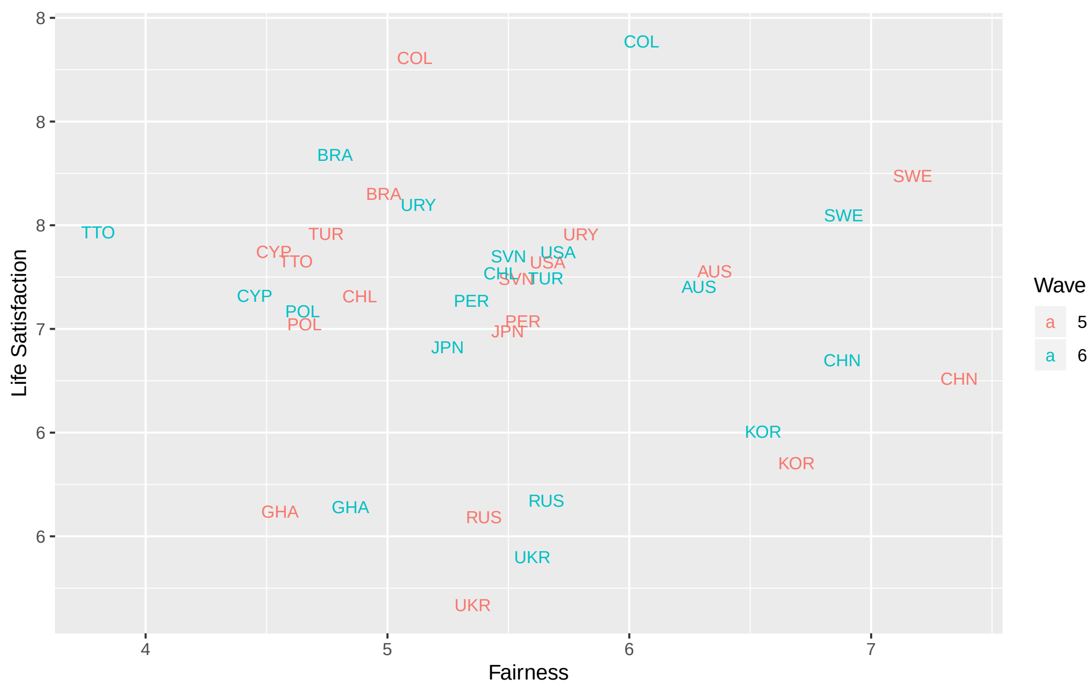

Figure 7: Fairness and Life Satisfaction across WVS Waves 5 and 6 (2005-2014). Subset of countries where Life Satisfaction does not significantly change across waves.

5 Concluding remarks

We provide microfoundations for the discussion of how beliefs and welfare relate, based on a general equilibrium setup in which anonymous interactions take place. The model allows for the exploration of common beliefs such as those surveyed by the WVS. The analysis suggests that the payoffs of the interaction induce strategic behavior such that in most cases, the proportion of agents participating in the productive interaction, efficiency, and welfare are directly related to optimistic or virtuous beliefs.

Nevertheless, such a relationship need not be monotonic, depending on the characteristics of the representative anonymous interaction. Indeed, we offer a parametrization that provides an example in which differences in beliefs about the behavior of others in general are not necessarily paired with welfare variations.

Our discussion points out the importance of the contents and context of social interactions and incentives therein when attempting to understand welfare and social capital. Widely used measures of beliefs should be complemented with indicators of the payoffs and preferences of social agents. Furthermore, our model emphasizes a specific comparison across outcomes regarding economic parameterizations. Different economies are different parameterizations of a model, and equilibria cannot be compared across parameterizations, unless the economies under consideration differ only on the dimensions of the parameter space.

School of Industrial Engineering, Pontificia Universidad Católica de Valparaíso.

Escuela de Negocios, Universidad Adolfo Ibañez.

A Proof of Proposition 1

For this, denote by $x_l(q, \phi, \beta)$ the Marshallian demand for good $l \in \{1, 2\}$ at price q given profile ϕ and beliefs β. The equilibrium price $\overline{q}$ and the consistent probability $\overline{\mu} = \mu(\{(\tilde{x}, \phi) : \phi \neq 0\})$ of agents participating in the interaction choosing $\phi = (r, a) \neq 0$ for some $(r, a) \in \mathbb{F}$ are characterized by 3 conditions:

(EC1) Market clearing for commodity 1:

$$\overline{\mu} x_1(\overline{q}, \phi, \beta) + (1 - \overline{\mu}) x_1(\overline{q}, 0, \beta) = (1 - \overline{\mu}).$$

(EC2) No deviation to or from not participating in the interaction:

$$u(x_1(\overline{q}, \phi, \beta), x_2(\overline{q}, \phi, \beta), \phi) = u(x_1(\overline{q}, 0, \beta), x_2(\overline{q}, 0, \beta), 0).$$

(EC3) No deviation to another strategy in the interaction:

$$u(x_1(\overline{q}, \phi, \beta), x_2(\overline{q}, \phi, \beta), \phi) \geq u(x_1(\overline{q}, \phi', \beta), x_2(\overline{q}, \phi', \beta), \phi'), \quad \phi' \neq \phi.$$

The conditions follow from the equilibrium requirements in Definition 2: (EC1) is associated with market clearing for the first commodity, from Definition 2 (1)(ii). (EC2) and (EC3) are incentive compatibilities in equilibrium, from Definition 2 (3). That is, there are no profitable deviations. Calculations for this setup where all three equilibrium conditions hold depend on β. Since there are only two possibilities, i.e., $\beta((H, H)) = 1$ or $\beta((L, L)) = 1$, there are two self-enforcing equilibria.

Therefore,

1. Assume that agents' beliefs are given by $\beta((H,H)) = 1$. Then, a proportion $\overline{\mu} = \frac{C_m}{2+C_m}$ of the agents choose to interact. Within each interaction, both agents decide to trust $\phi = (r, H)$ for each $r \in \{r_1, r_2\}$. A proportion $1 - \overline{\mu} = \frac{2}{2+C_m}$ do not engage in interactions. The equilibrium price is $\overline{q} = \frac{1}{C_m}$. All agents obtain the same level of utility $\frac{\sqrt{C_m}}{2}$.

2. Assume that agents' beliefs are given by $\beta((L,L)) = 1$; then, half of the agents choose to interact ($\overline{\mu} = 0.5$). Within each interaction, both agents decide not to trust, $\phi = (r, L)$ for each $r \in \{r_1, r_2\}$. The other half do not engage in interactions. The equilibrium price is $\overline{q} = 1$. All agents obtain the same level of utility 0.5. $\square$

B Proof of Proposition 2

The result follows from the characterization in Proposition 1. Note that the proportion of agents that engage in interactions (Proof of Proposition 1, (1)) is increasing in C_m. Therefore, it is clear that the proportion of agents that interact and trust increases as C_m increases. An identical argument shows that the utility level is positively related to C_m. $\square$

C Proof of Proposition 3

For every $C_m \in [1, 2]$, we have that $\overline{\mu}(\{(\tilde{x}, \phi) : \phi_a = H\}) \neq 0$ for beliefs $\beta((H,H)) = 1$ and $\overline{\mu}(\{(\tilde{x}, \phi) : \phi_a = H\}) = 0$ for beliefs $\beta((H,H)) = 1$. Moreover, $\overline{u}_H(C_m) > \overline{u}_L(C_m)$ for every $C_m \in (1, 2]$. That is, welfare is always higher when beliefs are $\beta((H,H)) = 1$ (see Figure 1). Nevertheless, when $C_m = 1$ we have $\overline{u}_H(C_m) = \overline{u}_L(C_m) = 0.5$. That is, generalized trust increases, but the welfare level coincides.

$\square$

D Proof of Proposition 4

The result follows by replicating the proof given in Proposition 1. The domination with respect to welfare by the equilibrium where $\beta((H,H)) = 1$ follows the argument in Remark 3.1. Specifically, given $\beta((H,H)) = 1$, the welfare level if both agents choose to trust should dominate the welfare if both agents choose to jointly deviate to betray but prices remain the same. The condition $m_1 \geq C_b/C_g$ ensures this. Furthermore, if we want to ensure that the welfare in the equilibrium with $\beta((H,H)) = 1$ is at least as large as the welfare in the equilibrium with $\beta((L,L)) = 1$, we arrive at the same condition, i.e., $m_1 \geq C_b/C_g$. Therefore, for any equilibria in the parametrization, we have a weak Pareto rank according to which trusting dominates. $\square$

References

Alberto Alesina and George-Marios Angeletos. Fairness and Redistribution. *American Economic Review*, 95(4):960–980, September 2005. ISSN 0002-8282. doi: 10.1257/0002828054825655. URL https://www.aeaweb.org/articles?id=10.1257/0002828054825655.

Stefano Bartolini, Małgorzata Mikucka, and Francesco Sarracino. Money, Trust and Happiness in Transition Countries: Evidence from Time Series. *Social Indicators Research*, 130(1):87–106, January 2017. ISSN 1573-0921. doi: 10.1007/s11205-015-1130-3. URL https://doi.org/10.1007/s11205-015-1130-3.

Sjoerd Beugelsdijk, Henri L. F. de Groot, and Anton B. T. M. van Schaik. Trust and economic growth: a robustness analysis. *Oxford Economic Papers*, 56(1):118–134, 2004. URL https://ideas.repec.org/a/oup/oxecpp/v56y2004i1p118-134.html.

Christian Bjørnskov. The Happy Few: Cross–Country Evidence on Social Capital and Life Satisfaction. *Kyklos*, 56(1):3–16, 2003. ISSN 1467-6435. doi: 10.1111/1467-6435.00207. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/1467-6435.00207.

Christian Bjørnskov and Pierre-Guillaume Méon. The Productivity of Trust. *World Development*, 70:317–331, June 2015. ISSN 0305-750X. doi: 10.1016/j.worlddev.2015.01.015. URL http://www.sciencedirect.com/science/article/pii/S0305750X15000169.

Luigino Bruni and Robert Sugden. Fraternity: Why the market need not be a morally free zone. *Economics & Philosophy*, 24(1):35–64, March 2008. ISSN 1474-0028, 0266-2671. doi: 10.1017/S0266267108001661. URL https://www.cambridge.org/core/journals/economics-and-philosophy/article/fraternity-why-the-market-need-not-be-a-morally-free-zone/D9277159DCACA80000C73D1F3B5922B1#.

Katalin Buzasi. Languages, communication potential and generalized trust in Sub-Saharan Africa: Evidence based on the Afrobarometer Survey. *Social Science Research*, 49:141–155, January 2015. ISSN 0049-089X. doi: 10.1016/j.ssresearch.2014.08.005. URL `http://www.sciencedirect.com/science/article/pii/S0049089X14001604`.

Steven N. Durlauf and Marcel Fafchamps. Chapter 26 - Social Capital. In Philippe Aghion and Steven N. Durlauf, editors, *Handbook of Economic Growth*, volume 1, pages 1639–1699. Elsevier, January 2005. doi: 10.1016/S1574-0684(05)01026-9. URL `http://www.sciencedirect.com/science/article/pii/S1574068405010269`.

Edward L. Glaeser, David I. Laibson, José A. Scheinkman, and Christine L. Soutter. Measuring Trust. *The Quarterly Journal of Economics*, 115(3):811–846, January 2000. ISSN 0033-5533, 1531-4650. doi: 10.1162/003355300554926. URL `http://qje.oxfordjournals.org/content/115/3/811`.

Luigi Guiso, Paola Sapienza, and Luigi Zingales. The Role of Social Capital in Financial Development. *The American Economic Review*, 94(3):526–556, 2004. ISSN 0002-8282. URL `https://www.jstor.org/stable/3592941`.

Russell Hardin. *Trust and trustworthiness*. Trust and trustworthiness. Russell Sage Foundation, New York, NY, US, 2002. ISBN 978-0-87154-342-4.

Noel D. Johnson and Alexandra Mislin. How much should we trust the World Values Survey trust question? *Economics Letters*, 116(2):210–212, August 2012. ISSN 0165-1765. doi: 10.1016/j.econlet.2012.02.010. URL `http://www.sciencedirect.com/science/article/pii/S016517651200050X`.

Stephen Knack and Philip Keefer. Does Social Capital Have an Economic Payoff? A Cross-Country Investigation. *The Quarterly Journal of Economics*, 112(4):1251–1288, 1997. ISSN 0033-5533. URL `https://www.jstor.org/stable/2951271`.

Malgorzata Mikucka, Francesco Sarracino, and Joshua K. Dubrow. When Does Economic Growth Improve Life Satisfaction? Multilevel Analysis of the Roles of Social Trust and Income Inequality in 46 Countries, 1981–2012. *World Development*, 93:447–459, May 2017. ISSN

0305-750X. doi: 10.1016/j.worlddev.2017.01.002. URL http://www.sciencedirect.com/science/article/pii/S0305750X17300049.

Peter Nannestad. What Have We Learned About Generalized Trust, If Anything? *Annual Review of Political Science*, 11(1):413–436, 2008. doi: 10.1146/annurev.polisci.11.060606.135412. URL https://doi.org/10.1146/annurev.polisci.11.060606.135412.

Elisha A. Pazner and David Schmeidler. A Difficulty in the Concept of Fairness. *Review of Economic Studies*, 41(3):441–443, 1974. URL https://econpapers.repec.org/article/ouprestud/v_3a41_3ay_3a1974_3ai_3a3_3ap_3a441-443..htm.

Denise M. Rousseau, Sim B. Sitkin, Ronald S. Burt, and Colin Camerer. Not So Different After All: A Cross-Discipline View Of Trust. *Academy of Management Review*, 23(3):393–404, July 1998. ISSN 0363-7425. doi: 10.5465/amr.1998.926617. URL https://journals.aom.org/doi/10.5465/amr.1998.926617.

Paola Sapienza, Anna Toldra-Simats, and Luigi Zingales. Understanding Trust. *The Economic Journal*, 123(573):1313–1332, 2013. ISSN 1468-0297. doi: 10.1111/ecoj.12036. URL https://onlinelibrary.wiley.com/doi/abs/10.1111/ecoj.12036. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/ecoj.12036.

Patrick Sturgis and Patten Smith. Assessing the validity of generalized trust questions: What kind of trust are we measuring? *International Journal of Public Opinion Research*, 22(1):74–92, 2010. ISSN 1471-6909(Electronic),0954-2892(Print). doi: 10.1093/ijpor/edq003.

Christian Thöni, Jean-Robert Tyran, and Erik Wengström. Microfoundations of social capital. *Journal of Public Economics*, 96(7):635–643, August 2012. ISSN 0047-2727. doi: 10.1016/j.jpubeco.2012.04.003. URL http://www.sciencedirect.com/science/article/pii/S0047272712000370.

Eric Uslaner. Measuring Generalized Trust: In Defense of the 'Standard' Question. In *Handbook of Research Methods on Trust*. Edward Elgar Publishing, 2011. ISBN 978-0-85793-201-3. doi: 10.4337/9780857932013. URL http://www.elgaronline.com/view/9781848447677.xml.

Paul J. Zak and Stephen Knack. Trust and Growth. *The Economic Journal*, 111(470):295–321, March 2001. ISSN 1468-0297. doi: 10.1111/1468-0297.00609. URL `http://onlinelibrary.wiley.com/doi/10.1111/1468-0297.00609/abstract`.

William R. Zame. Incentives, Contracts, and Markets: A General Equilibrium Theory of Firms1. *Econometrica*, 75(5):1453–1500, 2007. ISSN 1468-0262. doi: 10.1111/j.1468-0262.2007.00799.x. URL `https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1468-0262.2007.00799.x`.