Covid-19 lockdowns under imperfect redistribution: cross-country stylized facts and theory *

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Abstract

We analyze the relationship between income inequality, redistribution, and the stringency of governmental lockdowns imposed during the Covid-19 pandemic. We estimate the elasticity of the stringency with respect to the virus's reproduction rate using daily data from 157 countries. We find robust evidence that countries with lower inequality of disposable income and with greater income redistribution implemented stricter lockdowns in response to the same severity of the outbreak. We then interpret our results through the lenses of a stylized economic model with heterogenous agents, where countries differ in their ability to provide redistribution. We show, theoretically, that a higher cost of redistribution can make the trade-off between lives and livelihoods more severe if income redistribution itself has a small impact on labor supply decisions. Our results therefore suggest that, via its impact on policymakers' incentives to impose less stringent lockdowns, GINI could have made the pandemic worse.

Keywords: Covid-19, epidemics, inequality, Gini, stringency index

JEL codes: I19, I14, H23, H12

*The views expressed are those of the authors and do not represent the views of the U.S. Naval Academy, Marine Corps, Department of Defense, or the Federal Government. All errors are ours.

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1 Introduction

In response to the Covid-19 outbreaks governments imposed restrictions on economic activities. Empirical evidence suggests that the cost of those restrictions fell disproportionately on the lower-income households (Galasso, 2020; Adams-Prassl et al., 2020). Such households are more often employed in sectors affected by the lockdowns and have less resources to maintain their usual standard of living without a constant stream of income. As such, they rely more on the economic support provided by the government during the pandemic. If governments could not provide such support, would their lockdowns be less stringent? This is the question we address in this paper.

We start by documenting stylized facts on the stringency of economic restrictions imposed and the pre-pandemic levels of income inequality and redistribution. We find that countries with lower degree of pre-pandemic redistribution implemented, *ceteris paribus*, less severe restrictions. We then build a model with two trade-offs faced by policymakers: (i) the trade-off between lives and livelihoods, and (ii) the trade-off between equality and efficiency. We show that the second trade-off can amplify the first one, rationalizing the empirical patterns we found.

To the extent that official counts of new Covid-19 cases are more likely to be underreported in countries with higher inequality (which tend to be poorer and more autocratic), the same official number of new cases will in truth be larger in countries with a higher GINI coefficient. If that is the case, then our empirical estimate of the correlation between stringency response and inequality are biased upwards: if we regress a change in the index of economic restrictions on the virus's replication rate, interacted with inequality, then under the null hypothesis of identical policy response across countries, we should obtain a positive estimate of the coefficient on the interaction term. Our empirical analysis yields a negative estimate. Given the expected bias, that estimate can be interpreted as an upper bound: the negative relationship between inequality and the stringency response to the pandemic is even stronger.

Interestingly, and importantly for the point we make in this paper, the negative relationship only exists when we consider the inequality in disposable income rather than the income before all taxes and transfers. This suggests that the inability (or unwillingness) to provide sufficient income redistribution is negatively correlated with the stringency of economic restrictions, given the scope of the outbreak. Overall, we interpret our empirical results as evidence of a strong and statistically significant, negative relationship between disposable income inequality and the elasticity of economic restrictions with respect to the growth in new Covid-19 cases.

1.1 Literature Review

We contribute to numerous strands of literature that studied the economic aspects of Covid-19, with a particular focus on the differences in policy response, and the unequal impact of lockdowns and social distancing measures on different groups of people.

There is a large body of literature that has analyzed the impact of Covid-19 on potential future inequality. Naturally, most papers focused on the historical record from past pandemics (Sayed and Peng, 2020; Furceri et al., 2020). We analyze the opposite direction - how can the existing inequality affect the ongoing pandemic, with a specific focus on the relationship between lack of (or limited) income redistribution and the changes in the stringency of economic restrictions in response to the growth in new infections.

The study most closely related to ours is Davies (2021), who documents cross-country differences in Covid-19 death rates, and links them to differences in income inequality. He finds that death rates are higher in countries that have a higher GINI coefficient. Our main focus is on the lockdown policy response rather than the death rates, but the overall message is similar in spirit: countries that have a higher GINI coefficient fared worse, because they implemented less stringent lockdowns. We document it empirically, and provide a theoretical rationale for that finding.

Numerous studies emphasized the unequal impact of lockdowns on different income groups (Palomino et al., 2020; Bronka et al., 2020). Adams-Prassl et al. (2020) provide evidence on the ability to work from home by income groups. They document a positive correlation between a worker's earnings and the share of tasks that can be done from home by that worker, both in the United States and in the United Kingdom. For example, in the United States, the workers who fall in the annual income bracket of $40k - 49k$ can perform about 40% of their tasks from home. For those who fall in the annual income bracket of $80k - 89k$ that fraction exceeds 50%. Galasso (2020) showed that lower-income workers were most affected by the early lockdowns in Italy: they were more likely to lose a job, less likely to work from home, lost more of their income, and were more opposed to social distancing measures and other economic restrictions. Such unequal impact of lockdowns emphasizes the importance of income redistribution during the pandemic. Our empirical results confirm it - countries with higher degrees of income redistribution (measured as the difference between ex-ante and ex-post Gini coefficient in 2019) implemented more stringent restrictions on economic activity.

This paper is also related to macro literature that focused on redistributive aspects of lockdowns (Glover et al., 2020; Hur, 2020) or the interaction between inequality and lockdowns (Mendoza et al., 2021). The latter study analyzed the role of a saturated healthcare system and argued that less developed countries imposed suboptimally weak lockdowns combined with transfers lower than optimal. We show that the degree of a country's typical pre-pandemic income redistribution is positively correlated with the stringency of lockdown during the pandemic. We also provide a theoretical rationalization behind it, which emphasizes the impact that costly redistribution has on the trade-off faced during the pandemic.

Finally, our paper contributes to the literature that looked at the political economy aspects of the pandemic (Desierto and Koyama, 2020; Painter and Qiu, 2020; Giommoni and Loumeau, 2020; Bisbee and Honig, 2020). Particularly relevant are studies that analyze how lockdown stringency may impact policymakers' reelections chances. To that end, Desierto and Koyama (2020) point out that incumbents may impose less stringent lockdowns if their costs fall disproportionately on their electoral base. Our empirical results confirm those re-election concerns to some extent - the positive correlation between the degree of income redistribution and stringency of lockdowns appears more pronounced in countries that had elections scheduled in 2020 (although the statistical significance of the results is not robust across different empirical specifications).

2 Inequality and lockdowns: stylized facts

We use data from five sources. We use the stringency index from the Oxford COVID-19 Government Response Tracker (OxCGRT) dataset as a measure of economic restrictions.[1] We use daily data on virus's reproduction rate for each country from Our World in Data.[2] We use inequality data from the Standardized World Income Inequality Database (SWIID). Finally, we use the WHO data on the history of past outbreaks, similar to Covid-19 (MERS, SARS, and the Avian Flu).[3] Our data spans 152 countries over the period of 300 days. We end our analysis on December 31, 2020, to ensure that the cross-country differences in the availability of vaccines would have a minimal (if any) effect on our results.

We consider three measures of inequality, all based on the data from 2019: (1) log of the Gini index of income inequality after redistribution (`gini_disp`); (2) log of the Gini index of income inequality before redistribution (`gini_mkt`); and (3) the difference between (2) and (1). The third measure captures the degree of income redistribution.

[1] Available at: https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker

[2] Available at: https://github.com/owid/covid-19-data/tree/master/public/data.

[3] Available at: https://www.who.int/csr/don/archive/year/en.

We estimate the following regression:

$$\Delta str_{i,t} = \beta_1 \Delta str_{i,t-1} + \beta_2 r_{i,t-1} \left(1 + \gamma \texttt{inequality}_i + \alpha X_i\right) + u_i + z_t + \epsilon_{i,t} \tag{2.1}$$

where i denotes a country, t denotes a day, `str` is the log of the stringency index, r is the log of the virus reproduction rate, `inequality` is one of the three measures of inequality / redistribution mentioned above, and X is a vector of other country-specific characteristics: log of GDP per capita (in current USD from 2018) and a dummy variable that equals 1 if the country experienced outbreaks of a similar virus in the past (MERS, SARS, or the Avian Flu). We computed seven-day averages of the two daily variables (stringency index and reproduction rate) before taking logs. We include country fixed effects (u_i) to control for the unobserved heterogeneity across countries. We also include weekly fixed effects (z_t) to control for factors that affect all countries.

Naturally, we cannot identify any causal relationships. The same unobservable characteristics that impact inequality and redistribution may affect the elasticity of stringency (e.g., preference for libertarian policies). We interpret our results as a set of stylized facts that should guide the development of models focusing on the cross-country differences in policy response to the pandemic.

One problem with the estimation of (2.1) is potential bias in our estimate of γ, resulting from either (i) measurement error on `r` or (ii) omitted variables, both correlated with `inequality`. The measurement error poses a problem, because the reproduction rate of the virus is based on the official data on new infections that can be systematically underreported by government officials. We do not know how large this underreporting was on a daily basis. We have, however, estimates of cumulative underreporting available for a subsample of countries (Rahmandad et al., 2021). Figure 1 shows the relationship between such cumulative country-level underreporting and two country-level characteristics: per capita income and redistribution. The relationship is not very strong and is based on a much smaller sample than ours. Still, poorer countries with lower degree of redistribution have been more likely to systematically under-report official Covid-19 infections. Hence, the same official reproduction rate would in truth be higher (or, at worst, the same) in a country with a higher Gini coefficient, generating an upward (downward) bias in our estimate of the coefficient on the Gini index (redistribution). The omitted variable bias is harder to sign, and there is not much we can do about it. To the extent possible, we try to minimize it by controlling for GDP per capita in our regression.

Table 1 presents our results. The main takeaway is that the correlation between the outbreak elasticity of stringency index and the pre-pandemic degree of redistribution is positive (columns (3) and (6)). The importance of the redistribution can also be deduced from the differences between the estimated coefficients

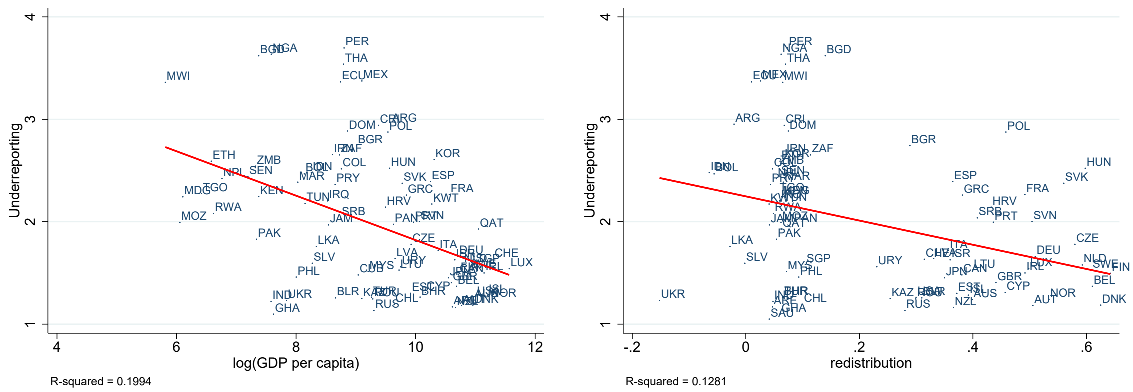

Figure 1: Underreporting (source: Rahmandad et al. (2021))

of γ on `gini_disp` and `gini_mkt` — the coefficient on the market Gini is not statistically different from zero.

Overall, our results indicate that given the severity of outbreak, higher inequality is associated with lower stringency of economic restrictions. In spirit, our results are consistent with Davies (2021), who documents positive relationship between various measures of adverse health outcomes and pre-pandemic levels of income inequality.

3 Costly redistribution and lockdowns: theory

We interpret the empirical patterns through the lenses of a simple model that in our view captures important challenges faced by policymakers. We use the heterogenous agents framework from Michaud and Rothert (2018), with two types of households: fraction N^R is "rich", and $N^P \equiv 1 - N^R$ is "poor". The only source of income is labor. The unit of labor supplied by the rich (poor) households yields one unit ($\gamma < 1$ units) of output.

Lives vs. livelihoods We focus on the redistributive margins alone, so we consider a static framework and do not build a formal epidemiological model. Instead, we model the overall severity of the outbreak that the country suffered over the course of the whole pandemic. We denote it with p. Among the factors that would increase p are the peak of the infection curve, the % of population infected, or the % of population that died.

Table 1: Dependent variable is $\Delta str_{i,t}$

Variables	(1)	(2)	(3)	(4)	(5)	(6)
$str_{i,t-1}$	-0.005***	-0.006***	-0.005***	-0.004***	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$r_{i,t-1}$	0.061**	-0.030	-0.001	0.046***	0.016	0.006
	(0.026)	(0.042)	(0.005)	(0.018)	(0.027)	(0.005)
r × income	0.002***	0.003***	0.000	0.000	0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
r × SARS	0.010***	0.011***	0.010***	0.004**	0.005**	0.005**
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)
r × gini_disp	-0.020***			-0.012***		
	(0.007)			(0.005)		
r × gini_mkt		0.004			-0.005	
		(0.011)			(0.007)	
r × redistribution			0.039***			0.019***
			(0.008)			(0.006)
Constant	0.021***	0.023***	0.019***	0.090***	0.090***	0.093***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)
Observations	48,084	48,084	48,084	48,084	48,084	48,084
R-squared	0.058	0.053	0.065	0.172	0.170	0.173
Weekly fixed effects	NO	NO	NO	YES	YES	YES
N	152	152	152	152	152	152

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; standard errors in parentheses (clustered by country)

The trade-off between lives and livelihoods would, in general, be given by:

$$p = N^P \cdot \pi_P\left(\ell^P\right) + N^R \cdot \pi_R\left(\ell^R\right) \tag{3.1}$$

where $\pi_i(\cdot)$ denotes the impact of ℓ^i on p.[4] We interpret them as the individual probabilities of getting infected by household i working ℓ^i hours. Empirical evidence in Adams-Prassl et al. (2020) suggests that lower-income households find it more difficult to work remotely, implying that $\pi_P > \pi_R$ and $\pi'_P > \pi'_R$. We will consider an extreme case here, assuming that $\pi_R \equiv 0$. To ensure a well defined problem we assume that $\pi'_P > 0$, and $\pi''_P \geq 0$.[5]

Equity vs. efficiency The lives-livelihoods trade-off is potentially amplified by the equity-efficiency trade-off, because redistribution is costly. The budget constraints for the two households are given by:

$$c^P \leq \gamma\ell^P + T \tag{3.2}$$

$$c^R \leq \ell^R - \frac{N^P T}{N^R} - \frac{\kappa\phi\left(N^P T\right)}{N^R} \tag{3.3}$$

where T is a transfer a typical poor household receives, $\kappa \geq 0$ is a parameter which captures the cost of redistribution, and $\phi(\cdot)$ is a continuous, differentiable, convex function with $\phi(0) = 0$, $\phi(x) > 0 \iff x \neq 0$. The cost of redistribution captures both the administrative costs of tax collection and provision of welfare payments[6], as well as the adverse impact on incentives known from the optimal Mirrlees taxation literature.[7]

A household of type $i = P, R$ has utility function of the form:

$$U\left(c^i, \ell^i; p\right) = u\left(c^i\right) - v\left(\ell^i\right) - \pi_i\left(\ell^i\right) h(p)$$

where $h(p)$ is the welfare cost a household would suffer if infected. Of course, an individual household takes p as given. We assume that cost is a function of the overall severity of the outbreak in the whole country. To ensure a well defined problem we assume that $u', v', -u'', v'', h' > 0$, and $h'' \geq 0$.

[4] Similar formulation can be found in Rothert (2021b).

[5] Rothert (2021a) shows that cumulative health costs in the SIR model are a convex function of the contact rate, when the contact rate is small.

[6] For example, Mawejje and Sebudde (2019) document that tax collection is less efficient in poorer countries.

[7] See Mirrlees (1971) and the literature that followed.

3.1 Ramsey Problem

The Ramsey Problem of finding an optimal allocation subject to the poor household's budget constraint is as follows:

$$\max_{i=R,P} \sum N^i \left[u\left(c^i\right) - v\left(\ell^i\right) - \pi_i\left(\ell^i\right) h\left(p\right)\right]$$

subject to (3.2), (3.1), and:

$$N^R c^R + N^P c^P \leq N^R \ell^R + N^P \gamma \ell^P - \kappa \cdot \phi\left(N^P T\right) \tag{3.4}$$

Including constraint (3.2) ensures the resulting allocation can be implemented as an equilibrium allocation with appropriately chosen distortionary taxes. It is straightforward to show that the Ramsey allocation satisfies the following conditions:

$$u'\left(c^P\right) = u'\left(c^R\right) \cdot \left[1 + \kappa \phi'\left(N^P T\right)\right] \tag{3.5}$$

$$v'\left(\ell^P\right) = \gamma u'\left(c^P\right) - \pi'_P\left(\ell^P\right) h(p) - \pi'_P\left(\ell^P\right) h'(p) p \tag{3.6}$$

$$v'\left(\ell^R\right) = u'\left(c^R\right) \tag{3.7}$$

Equation (3.5) describes a wedge between marginal utilities of consumption of the poor and the rich households that results from costly redistribution. If $\kappa = 0$ redistribution would be perfect. With $\kappa > 0$ we will have $c^P < c^R$.

3.2 Equilibrium with lockdowns

We model lockdowns in a manner similar to Eichenbaum et al. (2020) - as a tax imposed on economic activity that is then lump-sum rebated to households. Specifically, we model it as a tax on labor income, so that the problem of a representative poor household becomes:

$$\max u\left(c^P\right) - v\left(\ell^P\right) - \pi_P\left(\ell^P\right) h(p) \quad \text{subject to: } c^P \leq \left(1 - \tau^P\right) \gamma \ell^P + T + z,$$

where $z \equiv \tau \gamma \ell^P$ are taken as given by the household. The problem for the rich household is analogous. Since the proceeds from the tax are lump-sum rebated, only substitution effect associated with the labor income tax will be present. Therefore, a positive tax will necessarily reduce labor input and, consequently, the overall level of economic activity.

It is worth reminding that the equilibrium allocations in the economy with labor income taxes that are lump-sum rebated to the households will be identical to the equilibrium allocation in an economy with appropriately chosen quantitative restriction on labor input $\ell^i \leq \overline{\ell^i}$, $i = P, R$. Formally, for any vector of positive tax rates (τ^P, τ^R), there exists a vector $(\overline{\ell^P}, \overline{\ell^R})$ such that the labor allocations in the economy with taxes are $\ell^i = \overline{\ell^i}$, $i = P, R$.[8]

The equilibrium MRS between consumption and hours worked for the poor households is then:

$$v'\left(\ell^P\right) = (1 - \tau_P)\gamma u'\left(c^P\right) - \pi_P'\left(\ell^P\right) h(p) \tag{3.8}$$

Together, (3.8) and (3.6), yield the optimal stringency index:

$$\tau^* = h'(p) \cdot p \cdot \frac{\pi_P'\left(\ell^P\right)}{\gamma u'\left(c^P\right)}$$

3.3 Characterization

The following lemma will be useful in further characterization.

Lemma 3.1. *Let $\hat{z}(\kappa)$ denote the optimal allocation in the economy with the cost of redistribution given by κ, with a similar notation for individual elements of z. Then $\hat{\ell}^P(\kappa_1) \leq \hat{\ell}^P(\kappa_2)$, $\hat{c}^P(\kappa_1) \geq \hat{c}^P(\kappa_2)$, and $\hat{p}(\kappa_1) \leq \hat{p}(\kappa_2)$ if and only if $\kappa_1 \leq \kappa_2$.*

Proof. The proof is by contradiction and uses (3.1), (3.5), and (3.6), combined with and the economy resource constraint. Available upon request. □

Lemma 3.1 makes an important point. Costly redistribution results in a higher supply of labor by the poor household and, via (3.1), in higher overall severity of the outbreak. In that sense — higher GINI makes pandemic worse. The impact of the costly redistribution on the lockdown stringency is summarized in Proposition 3.2.

Proposition 3.2. *Let τ^* be the optimal stringency index. Then, $\frac{\partial \tau^*}{\partial \kappa}$ is increasing in the impact of redistribution on labor supply. In particular, $\lim \frac{\partial \tau^*}{\partial \kappa} < 0$ if that impact approaches zero.*

Proof. Consider $\log(\tau^*)$ instead, given by:

$$\log \tau^* = \log\left(h'\left(p\right)\right) + \log(p) + \log\left(\pi_P'\left(\ell^P\right)\right) - \log(u'(c^P)) + \text{constant}$$

[8] The logic here is the same as in Rothert (2016) who shows that, in a small open economy, a lump-sum rebated tax/subsidy on savings is equivalent to a quantitative limit on net foreign asset position. The proof relies on the comparison of the necessary and sufficient first order conditions and is omitted.

We then have:

$$\frac{d\log\tau^*}{d\kappa} = \underbrace{\left[\left(\frac{h''}{h'}+\frac{1}{p}\right)\pi'_P+\frac{\pi''_P}{\pi'_P}\right]}_{>0}\frac{d\ell^P}{d\kappa} - \underbrace{\frac{u''}{u'}\frac{dc^P}{d\kappa}}_{<0}$$

The second part of the proposition is then immediate, because we would have $\frac{d\ell^P}{d\kappa} = 0$. As the impact of redistribution on labor supply increases, $\frac{d\ell^P}{d\kappa}$ increases and $\frac{dc^P}{d\kappa}$ gets smaller (in absolute terms), leading to an increase in $\frac{d\log\tau^*}{d\kappa}$. □

The equity-efficiency trade-off affects the lives-livelihoods trade-off in a subtle manner. On one hand, costly redistribution reduces consumption of the poor households, which increases the marginal cost of lost labor income for those households, thereby reducing the policymakers' incentive to impose lockdowns. On the other hand, a more costly redistribution results in a higher labor supply by the poor households. This leads to a higher p which incentivizes the planner to impose stricter lockdowns. The first effect will dominate as long as the impact of redistribution on labor supply is not too strong.

4 Conclusions

The Covid-19 pandemic highlighted existing inequalities within and across countries. Lower income households fared worse, poorer countries have a more difficult access to available vaccines. The analysis in this paper points to yet another channel through which economic inequality might have affected the scope of the pandemic. Income inequality combined with costly redistribution affects policymakers' trade-off between curbing the outbreak and keeping the economy open. We found that countries which had a better developed system of income redistribution imposed more stringent restrictions on economic activity in response to the same severity of the outbreak.

Our analysis highlights the importance of a well functioning system of income redistribution. One can argue that in normal times the inability to provide income redistribution creates strong incentives to exert effort, as one cannot rely on public assistance. During a pandemic, when policymakers face trade-offs between lives and livelihoods, such inability makes that trade-off more severe. Finally, numerous papers emphasized the existence of substantial spillovers of infections across countries and regions (Eckardt et al., 2020; Rothert et al., 2020; Renne et al., 2020). Our results therefore suggest that the inability to provide sufficient income redistribution in some countries could have made the Covid-19 pandemic worse. The extent to which that is the case is an open, empirical question.

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A Proof of Lemma 3.1 - not for publication

Suppose $\kappa_1 \leq \kappa_2$ and suppose that $\ell_1^P > \ell_2^P$, implying, via (3.1) that $p_1 > p_2$. Additionally, we would have $\pi'_P(\ell_1) > \pi'_P(\ell_2)$. Then (3.6) implies that $c_1 < c_2$, because we would have:

$$v'(\ell_1^P) + \pi'_P\left(\ell_1^P\right)h(p_1) + \pi'_P\left(\ell_1^P\right)h'(p_1)p_1 > v'(\ell_2^P) + \pi'_P\left(\ell_2^P\right)h(p_2) + \pi'_P\left(\ell_2^P\right)h'(p_2)p_2.$$

Next, notice that $\ell_1^P > \ell_2^P$, combined with $c_1 < c_2$ implies that $T_1 < T_2$, so the total resource cost of redistribution is smaller. Equation (3.5) then implies that $u'(c_1^R) > u'(c_2^R)$, so $c_1^R < c_2^R$. The economy resource constraint then implies that $\ell_2^R < \ell_1^R$, so $v'(\ell_1^R) < v'(\ell_2^R)$, which, combined with $u'(c_1^R) > u'(c_2^R)$ yields a contradiction, via (3.7).