The Role of the Informal Sector in the COVID Crisis: A Cushion or an Amplifier?*

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Abstract

Labor informality, common in Latin American economies, is both a cause of low productivity and vulnerability, and a buffer that mitigates job destruction after negative shocks. In the current circumstances, informality is also associated with a higher risk of contagion, thus reducing the willingness of households to get involved in informal activities. To understand and quantify these mechanisms, we propose an SIR model featuring a dual labor market, where households imperfectly substitute informal and formal consumption, and calibrate it to Colombian and Peruvian data. Considering a higher risk of contagion from the informal sector doubles the size of the recession, whereas having less rigidities in markets allows for a faster recovery. Targeting transfers and using selective lockdowns have a similar epidemiological effect as its non-targeted counterparts, but at a lower economic cost. The paper also casts light on the inconvenience of long lockdowns.

Keywords: Informality, Covid, crisis, consumption.

JEL Codes: E21, E24, E26, E32.

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1 Introduction

Employment in developing countries has a big component of informality. This makes workers' income more fragile to business cycles and their consumption more volatile given the lack of access to social protection. Informal labor markets are, however, generally more flexible than formal markets. The absence of controls and regulations allows informal employment to absorb part of the destruction of the formal sector in presence of negative economic shocks (Leyva and Urrutia (2020b)). However, Leyva and Urrutia (2020a) have documented an initial decrease in informality during the beginning of the COVID pandemic for five Latin American countries, highlighting the specificity of the current crisis and the challenges for a faster recovery. In this paper, we argue the pandemic has led to a deeper depression of the informal sector because households perceive a greater risk of contagion from participating in it. We seek to understand and quantify these countervailing mechanisms to study the role of informality in the eventual recovery of developing countries from the COVID crisis and evaluate different public policies that can accelerate such recovery within this framework.

The present crisis threats to destroy a considerable amount of formal employment in countries where, beyond informal workers, firms are small and unable to face long periods of illiquidity. Recent crises have shown that the informal labor market absorbs an important part of the formal employment destruction with ambiguous consequences for long-term growth (Colombo et al. (2019)). On the one hand, the informal employment allows for a quicker recovery of consumption demand (at least partially) and acts as a form of income insurance for workers in absence of formal welfare networks. On the other hand, informal jobs are less productive and mainly related with low value-added sectors, leading to a low-quality recovery, and hindering long-term growth rate (Ulyssea (2018)).

Another important feature of informality, directly related with the present health crisis, is the difficulty it has to comply with biosecurity protocols. By definition, informal activity is not subject to public surveillance and the informal worker is not protected against occupational risks. This may lead to a higher exposure to contagion. The perception of an increased risk of participating in the informal sector leads households to decrease the demand for informal goods and workers to avoid working in the informal sector.[1] Both reactions, in turn, decrease the ability of the informal sector to lead the recovery from the crisis.

To understand the effect of these mechanisms, we propose a model composed of a continuum of households and a representative firm, embedded within an epidemiological structure. There is a formal and an informal sector in both the goods and the labor market. Households demand both types of consumption goods, which are imperfect substitutes, and are endowed with one unit of indivisible labor and a productivity drawn from

[1] That households voluntarily lower their economic activity when facing the risk of contagion during the pandemic has been documented by Maloney and Taskin (2020).

a known distribution. Households can be either formally employed in a formal firm to produce formal goods or producing informal goods by their own.

The representative formal firm produces the formal good with a linear technology that aggregates the productivity of its workers and pays a minimum wage to each one of them. We assume a zero-profit condition for the formal firm, and thus the firm hires all workers whose productivity is greater than a threshold in such a way that the average productivity is equal to the real formal wage. As in Hansen (1985), the remainder of households work in the informal sector with a probability and are unemployed with the complementary probability. The household chooses these probabilities in order to maximize its expected utility. As a result of the lottery, unemployed households enjoy the same income as informal workers.[2]

Economic agents interact in a risky environment where they can contract a contagious disease. To model this, we embed the production economy within an epidemiological (SIR) model as in Eichenbaum et al. (2020). Households can be susceptible to an epidemiological virus, infected with it or recovered from it. Those recovered do not have a risk of becoming infected again.[3] Those Infected can recover, die, or remain Infected, and their productivity decreases as a consequence of the illness. Susceptible households can become infected with a probability that increases with the number of infected people, the amount of formal and informal goods demanded and the labor provided in both the formal and the informal sector. The risk of contagion from interaction in the informal sector is higher, following the approach suggested by Krueger et al. (2020).

We calibrate the model to Colombian and Peruvian data to provide a comparison of two developing countries with different structures in their economy that generated differences in their performance. Informal goods have more weight in the Peruvian consumption bundle. In terms of the labor market, the Peruvian economy has a higher share of informality but a lower minimum wage relative to average informal income when compared to Colombia. Both governments have also differed in their policies and relative targeted lump sum transfers have been lower for Peruvian households.

The model provides rich dynamics on the amount of susceptible, infected, recovered and dead households; as well as aggregate production. The model replicates quite well the observed dip in both economies, including unemployment. Considering a different risk of contagion for informal economies doubles the size of the recession and slows recovery when compared to the standard calibration of Eichenbaum et al. (2020) since households imperfectly substitute large amounts of informal consumption for smaller amounts of formal consumption. Having sticky prices deepens the fall in aggregate consumption by 1pp for Colombia and 0.5pp

[2] Our simple approach on the labor market is therefore frictionless. There are recent advances on search and matching frictions with formal and informal labor, as in Haanwinckel and Soares (2021), which development within a SIR structure is left for future work.

[3] Or at least are inmune while they are vaccinated.

for Peru since the lack of demand during the crisis pushes down the relative price of the formal good. The analysis suggests that flexible prices and smaller distortions in the labor market (measured as the minimum formal wage relative to the median informal wage) are key for a faster recovery.

The pandemic generates an equilibrium that is not socially optimal due to the lack of internalization of the impact on the spread of the virus by infected people. Our framework allows us to seek for potential policies that increase the welfare of this economy. Among the policies that we evaluate are selective and general lockdowns, universal and targeted transfers to unemployed and informal workers, and combinations of these policies. We show that providing transfers deepened the recession by 2.4pp in Colombia and 1.4pp in Peru since households react to them reducing their labor supply. The difference between both countries is explained by the relative higher transfers implemented in Colombia and the less distorted labor market in Peru. We also show that targeting transfers to informal and unemployed households have the same epidemiological effects as universal transfers. Although universal transfers generate a small gain in formality by encouraging more spending, the size of the gain is not enough relative to its cost.

Lockdowns were used by governments as another tool to ease the toll of the pandemic. Our analysis shows that lockdowns are specially useful at the beginning of the pandemic lowering economic activity and, therefore, the rate of contagion. However, after a couple of months, when contagion is close to its peak, agents in the economy behave very similarly whether facing a lockdown or not, consistent with the evidence provided by Maloney and Taskin (2020) and Goolsbee and Syverson (2021). This suggests the inconvenience of long and strong lockdowns, as Assenza et al. (2020) have shown theoretically and Cakmaklı et al. (2021) have shown computationally for open economy emergent markets. Moreover, we show that selective lockdowns on the informal sector generate a very similar effect as complete lockdowns at the beginning of the pandemic, while also encouraging formality.

The use of SIR models within macroeconomics has been pioneered by Eichenbaum et al. (2020), Alvarez et al. (2020) and Atkeson (2020). Thereafter, several papers have analyzed the optimality of quarantine policies. Among them, Glover et al. (2020) and Acemoglu et al. (2020) have argued in favor of targeted lockdowns in presence of age-heterogeneity. We propose a multi-sector model as in Krueger et al. (2020) and exploit the informality margin to target the lockdown.

Hevia and Neumeyer (2020) propose a small open economy model within an SIR structure to understand the effects of Covid on the labor market on developing countries. They model informality as a fixed proportion of hand-to-mouth agents, as opposed to formal workers who have access to international financial markets. In contrast, we let informality be endogenous and allow for unemployment in our model.

The closest to our proposed model is Alon et al. (2020). They consider formal and informal labor for aggregate production, where individuals sort out depending on their productivity. Then, they evaluate agespecific lockdown policies that impacts the formal, but not the informal sector. Although we abstract from the age composition of the economy, we allow for substitution between the informal and formal goods as a mechanism to reduce contagion. Our model is also richer on the possible policies a government can take to alleviate the economic shock beyond lockdowns.

Leyva and Urrutia (2020a) analyze the impact of the Covid crisis on the labor market for five Latin American countries, documenting an initial decline in the informality rate. They rationalize their results in an RBC model and identify the recession with labor supply shocks and sector-specific productivity shocks to the informal sector. In contrast, our model includes an epidemiological component that endogenously generates the aggregate shock over time that explains the initial decrease in informality.

Kandoussi and Langot (2020) developed a multi-sectoral matching model with heterogeneous workers according to their educational level, finding a differentiated impact of the pandemic on the unemployment rate depending on the worker's qualification degree, as well as a strong persistence of unemployment even if the lockdown period is reduced. On the other hand, Alfaro et al. (2020) examine the role of informality for recovery considering the IO linkages across sectors in Colombia and their exposure to the lockdown shock, in the spirit of Guerrieri et al. (2020). We deviate from their approach by ignoring heterogeneities across sectors and focusing on the heterogeneity derived from household decisions to obtain a demand for goods of the formal and informal sector. Our approach generates a slower recovery given the risk the households perceive from buying informal goods.

2 Setup

Our framework follows Krueger et al. (2020) by considering a multi-sector economy that we identify to formal and informal markets. The time is discrete and the horizon is infinite. There is a continuum $j \in [0,1]$ of individuals maximizing the objective function:

$$V = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U\left(c_t^j, n_t^j\right)$$

Where $\beta \in (0,1)$ is the discount factor, c_t^j denotes the consumption for individual j, n_t^j denotes the hours worked for individual j , and $u(.)$ is an increasing, concave and differentiable function. The expectation $\mathbb{E}_0$ is taken with respect to the possible future health status that we describe below.

Consumption c_t^j is an aggregator of formal and informal consumption with elasticity of substitution $\eta \leq 0$. Let c_{tf}^j be the consumption of formal goods and c_{tl}^j the consumption of informal goods and let γ_k be the weight of the (in)formal good on the composite bundle for $k = f, l$. Therefore:

$$c_t^j = \left(\gamma_f c_{tf}^{j^{1-\frac{1}{\eta}}} + \gamma_l c_{tl}^{j^{1-\frac{1}{\eta}}} \right)^{\frac{\eta}{\eta-1}}$$

The individual can work in the formal or the informal sector. We consider the framework proposed by Hansen (1985) where labor is indivisible and each household must decide whether to work in the formal n_{tf}^j or informal sector n_{tl}^j, or to remain unemployed u_t, with $n_{tf}^j + n_{tl}^j + u_t = 1$. Each household j is born with a productivity A^j for the formal sector that is drawn from a cumulative distribution $G(A)$. There is a representative formal firm that hires formal labor at a minimum wage w_t, pays payroll taxes τ and transforms labor into a formal good with price P_{tf}. Its production function is linear and aggregates the productivity of its workers: $y_{tf} = \int A^j n_{tf}^j \, dj$. We assume that the formal sector hires high productivity workers until its profits become 0. Therefore, there exists a threshold $\hat{A}$ such that the formal firm hires all the workers with productivity $A^j \geq \hat{A}$, where $\mathbb{E}\left[A | A > \hat{A}\right] = \frac{w_t(1+\tau)}{P_{tf}}$.

In the informal sector all individuals have the same productivity. They produce with their own technology in that sector, which follows a linear production function $y_{tl}^j = n_{tl}^j$. Let the price for the informal good be normalized to 1, which will be equal to the wage earned for working in the informal sector.

The population is divided in four groups: the susceptible with mass S_t, who may contract the disease but are not currently infected, the infected with mass I_t, the recovered who become immune to the disease with mass R_t, and the dead with mass D_t. We assume the risk of becoming infected for the susceptible depends on consumption and labor choices. Let π_t be the probability of type s to become infected, it is defined as:

$$\pi_t = I_t \left(\pi_{c_l} c_{tl}^s c_{tl}^i + \pi_{c_f} c_{tf}^s c_{tf}^i + \pi_{n_l} n_{tl}^s n_{tl}^i + \pi_{n_f} n_{tf}^s n_{tf}^i + \pi_0 \right)$$

Where π_{c_k} is a parameter determining the infection risk from consuming in sector $k = f, l$, with $\pi_{c_l} > \pi_{c_f}$. Similarly, π_{n_k} is a parameter describing the infection risk when working in sector k, with $\pi_{n_l} > \pi_{n_f}$. Finally, π_0 is the baseline probability of contagion even if individuals do not consume or work in the informal sector. The total number of newly infected people is given by $T_t = \pi_t S_t$. Following Eichenbaum et al. (2020), infected people have a decrease in productivity ψ, reflecting the expected effect of the illness.

The dynamics of the four groups evolves as follows:

$$S_{t+1} = S_t - T_t$$

$$I_{t+1} = I_t + T_t - (\pi_d + \pi_r) I_t$$

$$R_{t+1} = R_t + \pi_r I_t$$

$$D_{t+1} = D_t + \pi_d I_t$$

$$M_{t+1} = M_0 - D_t$$

Where π_d is the probability of death for an infected individual, π_r is the probability of recovery of an infected person, and M_t denotes the mass of individuals at time t. We assume that initial conditions are $I_0 = \epsilon$, $S_0 = 1 - \epsilon$, and $R_0 = D_0 = 0$.

3 Recursive formulation

As described before, households with a productivity $A^j \geq \hat{A}$ choose to work in the formal sector. The remainder portion of households, $G(\hat{A})$, choose a lottery such that with probability α the agent works in the informal sector $n_l = 1$ and with probability $1 - \alpha$ they remain unemployed, as in Hansen (1985). In this case, regardless of the intertemporal elasticity of substitution of labor and assuming a separable function, the utility function is defined as:

$$U(c, n) = \log c - \theta\alpha$$

for those that do not qualify for the formal sector[4]. The budget constraint of a household with productivity A^j is expressed as:

$$P_{tf} c^j_{tf} + c^j_{tl} \leq I_{A^j \geq \hat{A}} w_t n^j_{tf} + \alpha^j_t \tag{1}$$

where $\alpha^j_t n^j_{tf} = 0$ since participation in each sector is mutually exclusive.

We now represent recursively the problem for each type of individual. Let υ^s be the value function for susceptible individuals, υ^i the value function for infected, υ^r the value function for those recovered and normalize the value function for dead individuals to $\upsilon^d = 0$.

The problem to be solved by a susceptible, infected and recovered individual, respectively, is:

$$\upsilon^{sj} = \max_{c^s_f, c^s_l, n^s_f, \alpha^s} \log c^s - \theta n^s_f - \theta\alpha^s + \beta\left[(1 - \pi)\upsilon^s + \pi\upsilon^i\right]$$

$$\upsilon^{ij} = \max_{c^i_f, c^i_l, n^i_f, \alpha^i} \log c^i - \theta n^i_f - \theta\alpha^i + \beta\left[(1 - \pi_d - \pi_r)\upsilon^i + \pi_r\upsilon^r\right]$$

[4]For those willing to work in the formal sector we assume the marginal disutility of working is also θ, so there is no distortion in the threshold $\hat{A}$ since the probability of infection from working in the formal sector is lower than the one from working in the informal one.

$$v^{rj} = \max_{c_f^r, c_l^r, n_f^r, \alpha^r} \log c^r - \theta n_f^r - \theta \alpha^r + \beta \left[v^r \right]$$

subject to budget constraint (1).

For susceptible individuals the first order condition with respect to the consumption of good $k = f, l$ is:

$$\gamma_k \left(\frac{1}{c^s} \right) \left(\frac{c^s}{c_k^s} \right)^{\frac{1}{\eta}} = \lambda_b^s P_k + \beta \left(v^s - v^i \right) I \pi_{c_k} c_k^i$$

Where λ_b^s denotes the Lagrange multiplier corresponding to the budget constraint of a susceptible individual. Note that the risk of infection associated with the consumption of good k, the second term of the right-hand side, decreases the amount of consumption when compared to a world without pandemics. Since the risk of infection is greater for informal consumption, its demand will decrease relatively more in the peak of infection, a key mechanism for our results.

For low productivity workers, the decision with respect to α is also distorted by the risk of infection, thus they will reduce more their informal labor supply the greater their marginal probability of becoming infected:

$$\lambda_b^s = \theta + \beta \left(v^s - v^i \right) I \pi_{n_l} \alpha^i G \left(\hat{A} \right)^2$$

On the other hand, decisions for infected and recovered households are not distorted. The marginal rate of substitution for each type of consumption and for $h = i, r$ is:

$$\gamma_k \left(\frac{1}{c^h} \right) \left(\frac{c^h}{c_k^h} \right)^{\frac{1}{\eta}} = \theta P_k$$

Note that for these types of individuals the risk of infection is no longer relevant. However, since the two sectors, formal and informal, do not have the same prices, an infected individual will not necessarily distribute her consumption evenly between the formal good and informal good.

4 Public policy experiments

In our model, we simulate four public policy experiments. The first public policy exercise refers to the payment of lump sum transfers, in such a way that we simulate three scenarios; the first, in which the transfer is paid to the entire population, the second with a targeted transfer to informal workers and unemployed, which in our model refer to the mass $G\left(\hat{A}\right)$, and the third corresponds to the previous scenario but doubling the size of the lump sum transfer.

The second public policy experiment is intended to assess the impact of lockdowns in economic and epidemiological variables. One way to model this type of situation is through consumption taxes, as Eichenbaum et al. (2020) does. To do this, the impact of a generalized lockdown is simulated through a tax on the consumption of the formal good and the informal good in our model.

The previous exercises imply a modification of the budget constraint 1 of an agent j, in such a way that it would be now defined as:

$$(1+\mu)\left(P_{tf}c_{tf}^{j}+c_{tl}^{j}\right)\leq I_{A^{j}\geq\hat{A}}w_{t}n_{tf}^{j}+\alpha_{t}^{j}+T \quad (2)$$

where μ is the consumption tax and T is the lump sum transfer.

The third exercise seeks to simulate the impact of a selective lockdown on the informal sector, a situation that in our model we address by setting a consumption tax only on the informal good, with which the budget constraint of an agent j will be determined by:

$$P_{tf}c_{tf}^{j}+(1+\mu)c_{tl}^{j}\leq I_{A^{j}\geq\hat{A}}w_{t}n_{tf}^{j}+\alpha_{t}^{j}$$

The fourth experiment consists on lowering payroll taxes to decrease the tax burden for formal firms.

5 Calibration

We calibrate the model to Colombian and Peruvian economies to highlight the differences implied by each economic structure. The Peruvian economy has a less distorted labor market since its minimum wage for formal workers is close to the median informal wage and payroll taxes are also lower. However, the typical Peruvian consumption bundle has a higher share of informal goods and their informality rate is higher.

Table 1 summarizes the chosen values for parameters and their source. The impatience parameter β is standard in the literature. The elasticity of substitution between sectors is chosen according to Krueger et al. (2020) and we performed additional exercises for different values; however, elasticities above 5 do not generate substantial differences on the results. The weights for formal and informal goods are chosen to represent conservative approximations to the share of goods bought in informal markets.[5] The labor disutility parameter θ is calibrated to generate 40 weekly working hours. The productivity of infected people ψ follows Eichenbaum et al. (2020) and we calculate its contribution to the recession in Tables 2 and 4 for

[5]The biggest centers for contagion in Peru were informal markets since most households rely on them to do their daily shopping. Several consumer behavior surveys show Peru is, with Bolivia, the country with the largest share of the traditional retail channel (small proximity shops, open food markets, etc) in South America. While Colombia is one of the countries with the fastest growth in the share of online shopping, in recent years. The Kantar World Panel 2015 estimates the traditional channel share in 68% of the total expenditure in Peru, while it is 53% in Colombia. Furthermore, according to The National Household Surveys for Colombia and Peru (GEIH and ENH, respectively), while 52.5% of Peruvian households have a refrigerator, that number is 84% for Colombian households. This fact generates a need for Peruvian households to visit markets more often.

Colombia and Peru, respectively.

The relative formal wage w is calculated as the official hourly minimum wage relative to the median hourly informal wage according to the 2019 national surveys INH and GEIH. Payroll taxes are taken from OECD. The productivity distribution is approximated with an exponential distribution and its parameter is chosen to match the formal employment given the calibrated formal wage and the corresponding payroll taxes.[6] The government transfers given during the crisis are also expressed relative to the median hourly informal wage, these have been higher for Colombia than for Peru. Finally, the epidemiological parameters follow closely the ones suggested by Eichenbaum et al. (2020) but are slightly modified to reproduce the epidemiological data observed for both countries. We also report in Tables 2 and 4 the results for the calibration suggested by Eichenbaum et al. (2020), assuming the formal and informal sector have the same risk of contagion.

Table 1: Calibration.

Parameter	Colombia	Peru	Description	Source
β	$0.96^{\frac{1}{52}}$	$0.96^{\frac{1}{52}}$	Discount factor	Eichenbaum et al. (2020)
η	10	10	Elasticity of substitution	Krueger et al. (2020)
γ_f	1.2	0.8	Formal good weighting in consumption aggregator	Match relative expenditure weight
γ_l	0.8	1.2	Informal good weighting in consumption aggregator	Match relative expenditure weight
θ	0.0276	0.0276	Labor supply parameter	Match unemployment rate: DANE, INEI
ψ	0.8	0.8	Productivity of infected people	Eichenbaum et al. (2020)
w	1.26	1.07	Hourly minimum wage relative to median hourly informal wage	GEIH, ENH
τ	0.3	0.175	Payroll taxes	OCDE
κ	0.12	0.12	Hiring costs	Muehlemann and Leiser (2018)
λ	1.88	1.28	Exponential distribution for productivity	Match formal employment
T	13.68	8.15	Weekly lump sum transfer relative to median hourly informal wage	DNP, MEF
π_0	0.3902	0.3902	Autonomous Infection Intensity	Eichenbaum et al. (2020)
π_{c_l}	1.9602×10^{-7}	1.9602×10^{-7}	Infection risk from consuming - Informal sector	Match Laajaj et al. (2021) data
π_{c_f}	7.8408×10^{-8}	7.8408×10^{-8}	Infection risk from consuming - Formal sector	Match Laajaj et al. (2021) data
π_{n_l}	3.1105×10^{-4}	3.1105×10^{-4}	Infection risk from work - Informal sector	Match observed data
π_{n_f}	1.2442×10^{-4}	1.2442×10^{-4}	Infection risk from work - Formal sector	Match Laajaj et al. (2021) data
π_d	2.3333×10^{-4}	2.3333×10^{-4}	Death rate	Match Laajaj et al. (2021) data
π_r	0.2331	0.2331	Recovery rate	Match Laajaj et al. (2021) data

6 Results

We first report the results for Colombia along with the figures representing the epidemiological and economic path of the baseline calibration and the simulated policies. We then present the quantitative results for Peru comparing them with those for Colombia. We omit the figures for Peru since they are qualitatively similar to Colombia's.

[6]Formality is defined as suggested by the International Labor Organization (ILO) to have comparable measures between Peru and Colombia, since the Colombian National Department of Statistics (DANE) follows a different definition that leads to a lower rate of formality. Our metric closely follows the homogeneous estimations for both countries in Fernández et al. (2017), see table 2, page 142.

6.1 Colombia

Figure 1 shows the epidemiological path implied by the baseline calibration compared to that obtained with the calibration suggested by Eichenbaum et al. (2020) where there are no differential risks of contagion across sectors. The results show that considering a differential risk smooths the pandemic because agents substitute consumption from the riskier sector to the formal one. In fact, Figure 2 shows that the drop in informal consumption is ten times bigger that for formal consumption when there is a differential risk, which in turn generates a greater drop in aggregate consumption and a surge in unemployment (Figure 3). However, even though there is substitution towards the formal good, there is also a fall in its demand because it also entails a nonneglibible risk of contagion. This leads to a decrease in the price of the formal good that also decreases employment in the formal sector, which is greater due to a differential risk caused by a deeper recession.

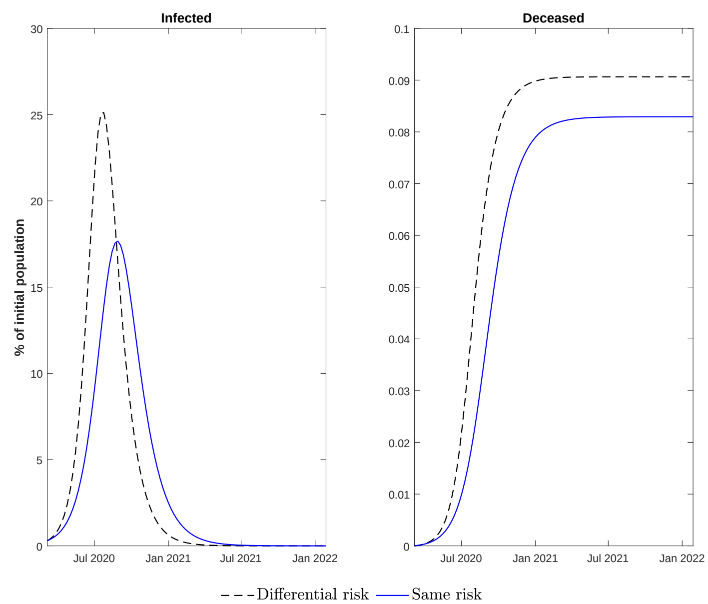

Figure 1: Epidemiological results

The dynamics of the infection generates an endogenous size of the shock that affects consumption and labor decisions. The higher the number of infected people, the riskier it is to participate in economic activities. Figure 2 shows that aggregate consumption falls 13.8% in our baseline calibration, compared to 7.3% for the case where there is no differential risk of contagion. This adjustment occurs mainly in the consumption of the informal good (-16%), which is partially substituted for formal consumption.

The results for the labor market mirror the previous ones. While both formal and informal employment decreases, Figure 3 shows a bigger drop in informal employment, decreasing from 55% to 40%. Formal

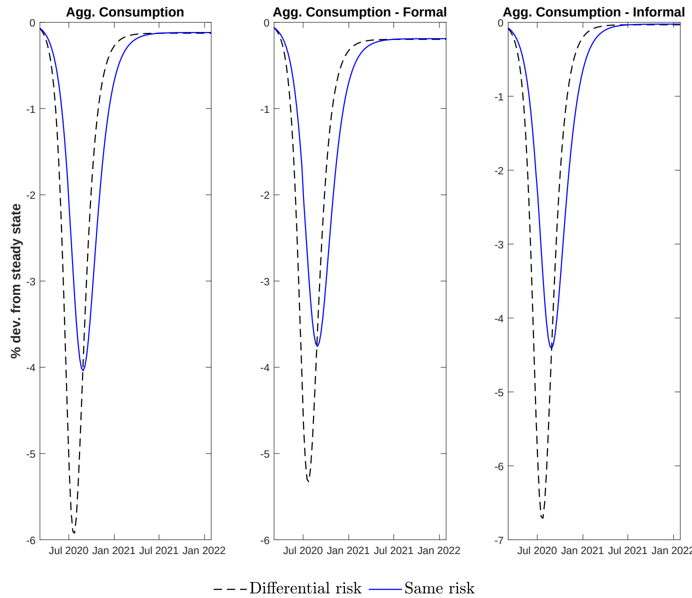

Figure 2: Consumption

employment also decreases because the lack of demand depresses the price of the formal good, thus increasing the real wage. The fall in the formal price is higher when there is a differential risk of contagion generating a bigger fall in formal employment. The drop in formal employment is likely to be bigger because firms face dynamic costs such as liquidity and contracting problems, which we abstract in our simpler model. Lost employment is absorbed by unemployment since there are no margins left in the model, increasing it in 16 percentage points.[7]

Table 2 presents the aggregate results of the pandemic in terms of annual fall of aggregate consumption, the maximum fall in aggregate consumption, the maximum unemployment rate and the amount of deceased individuals. The baseline calibration for Colombia suggests an annual fall of -4.13% and a maximum unemployment of 25%, while the deceased sum up to 0.56% of the population.[8] In a scenario of sticky prices, where the formal price does not adjust, the fall in aggregate consumption is even bigger because formal consumption drops even more, and the number of deceased agents increases because it is harder to substitute informal consumption. Considering a differential risk of contagion doubles the size of the recession given the large drop in informal employment, but it also decreases the number of fatalities due to the possibility to substitute consumption. Finally, reducing the productivity of infected people does not have an important impact on the aggregates.

[7] Actually, there was an important increase in inactivity as shown in Leyva and Urrutia (2020a).

[8] These statistics are similar to those of Carranza et al. (2020), who include initial immunity as a mechanism to rationalize the observed recession.

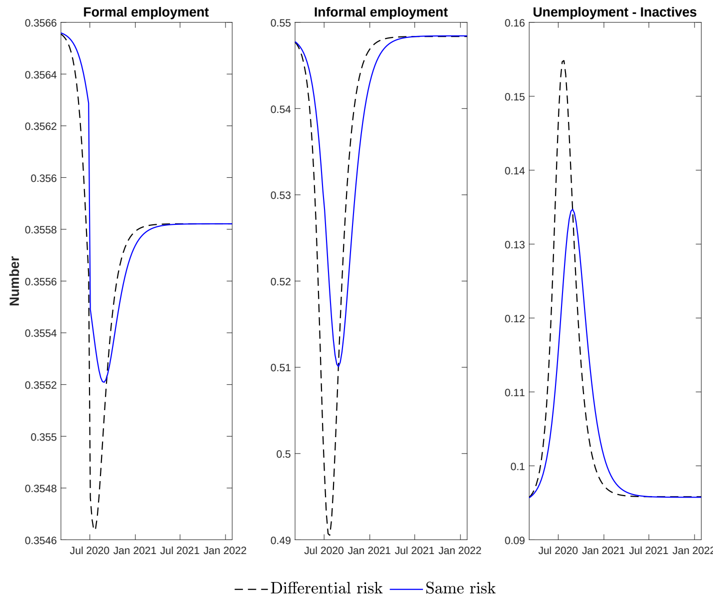

Figure 3: Employment

Table 2: Baseline results - Colombia.

Model	Annual fall Agg. Cons.	Max. Unemployment - Inactivity	Deceased
Observed	-6.21%	34.37%	0.0759%
Baseline	-1.81%	15.48%	0.0906%
Without reduction in productivity of infected people	-0.26%	10.61%	0.0907%
Same probability of infection in both sectors	-1.58%	13.47%	0.0829%
Sticky prices	-1.83%	15.52%	0.0906%

In the following subsections, we explore the role of public policies to smooth the pandemic. We first describe the results for targeted and non-targeted transfers. Afterwards, we evaluate the consequences of targeted and non-targeted lockdowns.

6.1.1 Lump sum transfers

One of the most widely used public policy to alleviate the crisis generated by the pandemic are lump sum transfers to vulnerable households. Figure 4 shows that transfers are successful at slowing the speed of the pandemic, the effect being more important the greater the transfers. Remarkably, the effect of targeted transfers is the same as the effect of universal ones.

Figure 5 shows that universal transfers generate a boost in formal consumption, that is even greater than the one generated by a duplication of transfers to vulnerable households. This boost increases the price of the formal good and increases the formality rate. However, their effect on the informal sector keeps

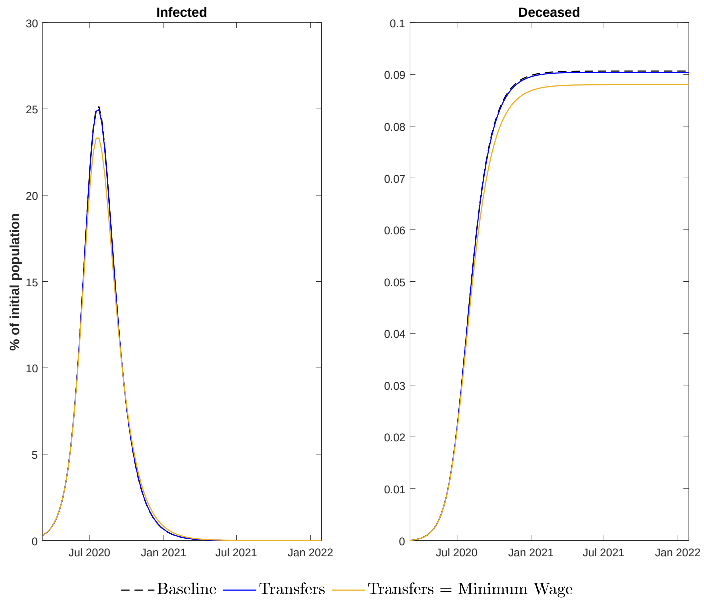

Figure 4: Epidemiological results - Lump sum transfers.

being very similar to the one produced by targeted transfers. Since such impact has a greater order of magnitude, the total impact on aggregate consumption remains similar. Doubling the targeted transfers generates an increase of 7 percentage points in unemployment, which is twice the unemployment generated by the calibrated transfers, as shown in Figure 6.

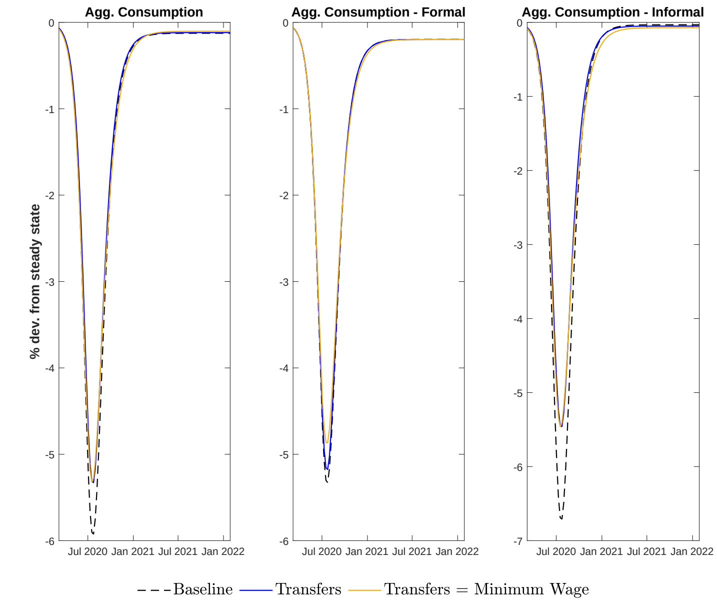

Figure 5: Consumption - Lump sum transfers.

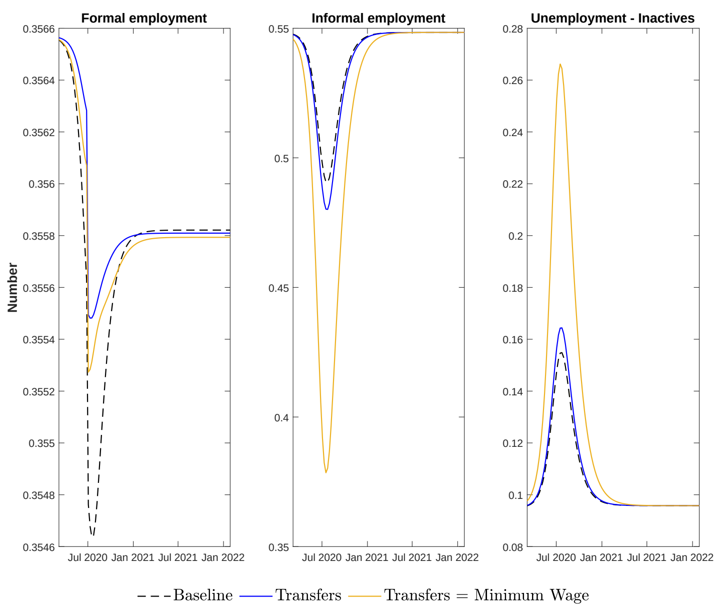

Figure 6: Employment - Lump sum transfers.

6.1.2 Lockdowns

Governments have also used lockdowns as a tool to slow agents interactions and smooth the peak of the pandemic. They have been particularly useful to prevent the saturation of ICU beds, which was proven to be key to reduce the fatalities in the US (Bravata et al. (2021)). Although we abstract for availability of ICU beds, lockdowns in our model are useful in reducing the transmission of the infection in early stages as they decrease consumption by making it more costly. To simulate the consequences of the lockdown, we perform computational exercises with the consumption tax set to 0.2 and 0.5. Figures 7 and 8 shows that during the weeks around the peak of contagion, households do not change significantly their decisions about informal consumption whether facing a lockdown or not. Thus it argues against long lockdowns, that can also have other costs such as decreasing individual liberties. Moreover, generalized lockdowns greatly affects formal consumption, preventing the effective substitution of informal for formal consumption.

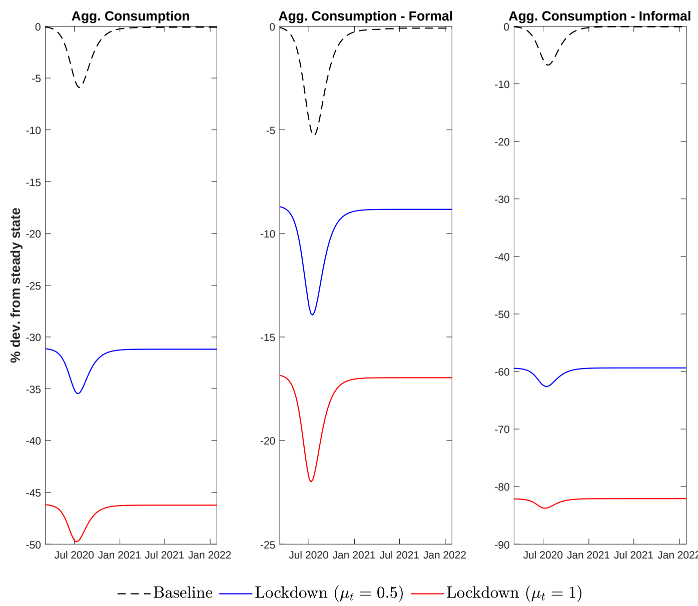

Figure 7: Consumption - Lockdown.

Selective lockdowns, as shown in Figures 9 and 10, generate a very similar reaction regarding the informal markets as the one observed for complete lockdowns. This translates into the same epidemiological results, but incentivizing formality and reducing the drop in aggregate consumption, thus potentially generating long term gains.

6.1.3 Summary

Table 3 summarizes the aggregate results for the simulated Colombian economy. Targeted transfers are superior to universal transfers as they generate the same quantitative results at a lower cost. Duplicating the targeted transfers importantly reduces the amount of deceased individuals, but it deepens the recession in almost 3 percentage points.

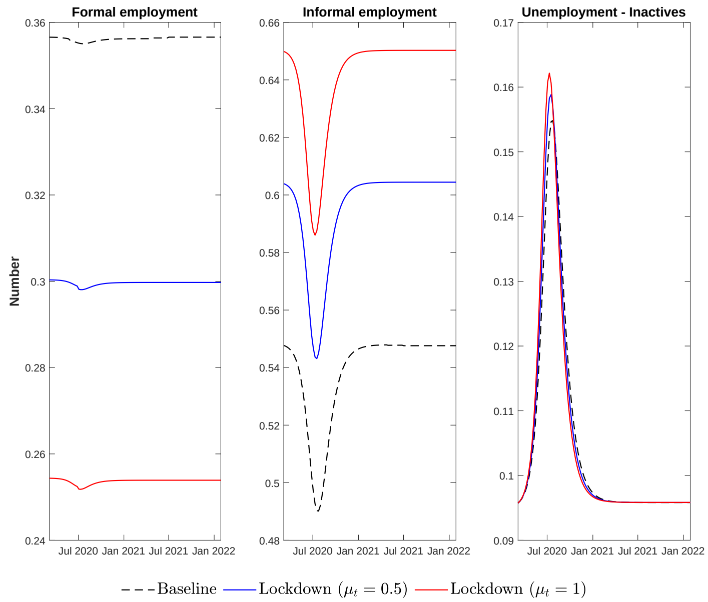

Figure 8: Employment - Lockdown.

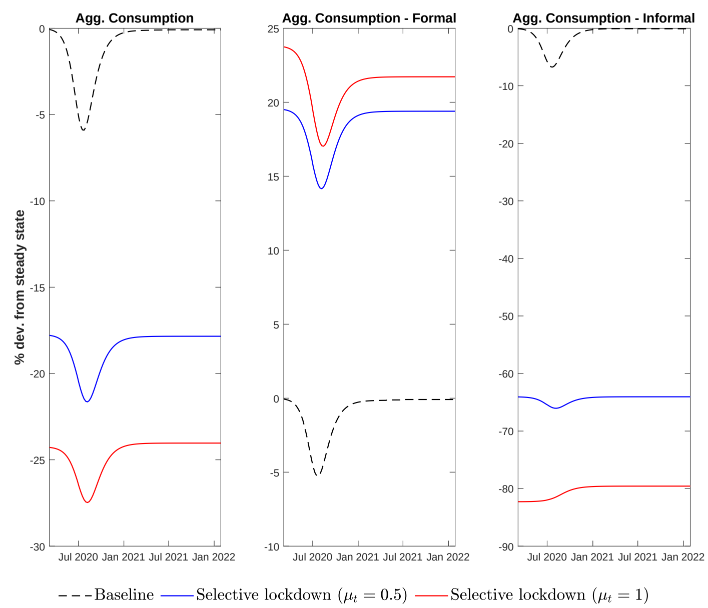

Figure 9: Consumption - Selective lockdown.

Lockdowns are also useful in reducing the spread of the disease by reducing economic activity in the first weeks of the pandemic. Selective lockdowns on the informal sector are preferred to complete lockdowns because they generate a substitution towards the formal sector that eases the drop of aggregate consumption

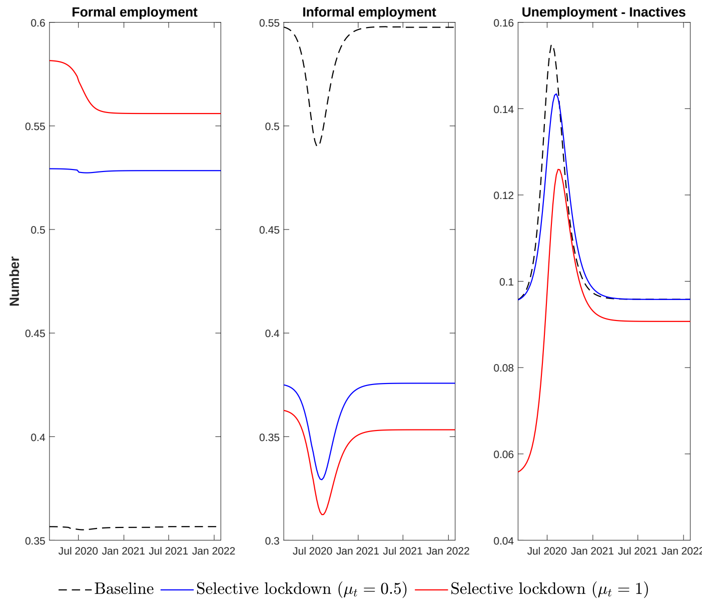

Figure 10: Employment - Selective lockdown.

with similar epidemiological results. A combination of targeted transfers and lockdowns, as in fact happened, lead to a greater dip in the economy.

Table 3: Policy experiments - Colombia.

Model	Annual fall Agg. Cons.	Max. Unemployment - Inactivity	Deceased
Observed	-6.21%	34.37%	0.0759%
Baseline	-1.81%	15.48%	0.0906%
Lockdown, $\mu = 0.5$	-32.36%	15.88%	0.0918%
Lockdown, $\mu = 1$	-47.17%	16.21%	0.0927%
Selective lockdown, $\mu = 0.5$	-19.06%	14.34%	0.0877%
Selective lockdown, $\mu = 1$	-25.32%	12.59%	0.0875%
Lockdown ($\mu = 0.5$) and targeted lump sum transfers	-27.32%	33.32%	0.0877%
Selective lockdown ($\mu = 0.5$) and targeted lump sum transfers	-18.85%	33.18%	0.0854%

6.2 Comparison with the Peruvian economy

The Peruvian economy has some distinct features compared to Colombia's. On one hand, the typical consumption bundle has a greater share of goods bought in informal markets, which makes households more prone to contract the virus. Second, it features a less distorted labor market since its minimum formal wage and its associated payroll taxes are closer to the median informal wage than its Colombian counterpart. Finally, the transfers made to vulnerable households were relatively lower.

This combination leads to a greater recession in terms of consumption, despite having lower unemployment. The fall in consumption is greater because the size of the informal sector and its corresponding fall is larger. Table 4 also shows the effect of alternative settings. Again, the differential risk of contagion doubles the size of the recession and having sticky prices generates a deeper fall of aggregate consumption of 0.5 percentage points. This drop is slightly greater than the one for Colombia because it prevents the substitution of informal consumption, which is substantially bigger.

Table 4: Baseline results - Peru.

Model	Annual fall Agg. Cons.	Max. Unemployment - Inactivity	Deceased
Observed	-8.61%	43.77%	0.3740%
Baseline	-1.98%	11.65%	0.0936%
Without reduction in productivity of infected people	-0.36%	5.51%	0.0937%
Same probability of infection in both sectors	-1.77%	8.91%	0.0849%
Sticky prices	-2.02%	11.78%	0.0936%

Table 5 shows the results for the different policy experiments. The qualitative results are similar to those for Colombia. However, transfers depress economic activity less because of their smaller size. Selective and general lockdowns have a similar effect for the Peruvian and the Colombian economies. The reason for this similarity, despite having a larger share of informal goods, is its less distorted labor market. Figure 11 shows a simulation for Colombia with the corresponding Peruvian payroll taxes and compares it with the baseline calibrations. It is clear that a lower distortion in the formal sector allows for a faster recovery through an increase in the formality rate, though unemployment exhibits the same path.

Table 5: Policy experiments - Peru.

Model	Annual fall Agg. Cons.	Max. Unemployment - Inactivity	Deceased
Observed	-8.61%	43.77%	0.3740%
Baseline	-1.98%	11.65%	0.0936%
Lockdown, $\mu = 0.5$	-31.41%	11.82%	0.0942%
Lockdown, $\mu = 1$	-46.23%	12.79%	0.0940%
Selective lockdown, $\mu = 0.5$	-23.35%	10.35%	0.0906%
Selective lockdown, $\mu = 1$	-24.75%	10.14%	0.0904%
Lockdown ($\mu = 0.5$) and targeted lump sum transfers	-25.39%	25.00%	0.0909%
Selective lockdown ($\mu = 0.5$) and targeted lump sum transfers	-18.83%	24.41%	0.0879%

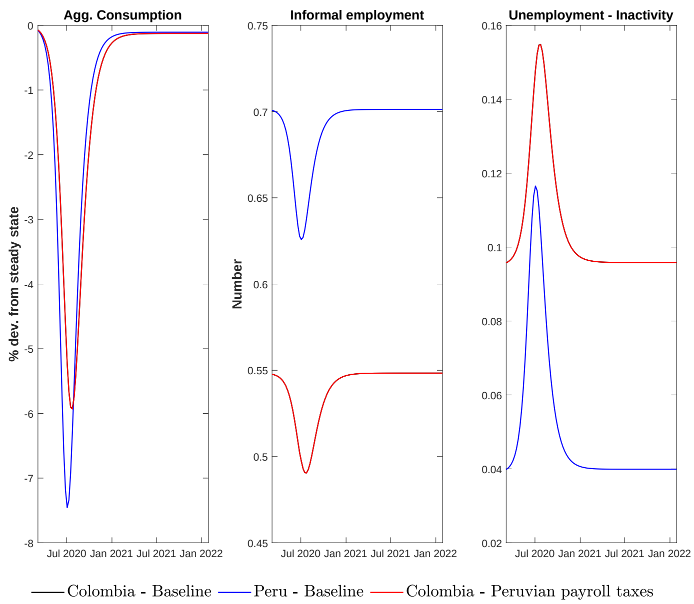

Figure 11: Consumption and employment.

7 Concluding Remarks

We provide a model to understand the role of informality in the recovery from the COVID crisis. We argue that a higher risk of contagion for the informal sector slows its ability to lead the recovery. The paper also highlights the role of flexible prices and less distorted labor markets to increase the speed of recovery.

We analyze the effects of four policy measures both in terms of contagion and in terms of economic activity: general lockdowns, lump sum transfers, targeted transfers and reductions in payroll taxes. Lockdowns reduce economic activity and, for this reason, decrease the spread of the disease. However, this policy is only effective in the first weeks of the pandemic. Selective lockdowns on the informal sector are better than complete lockdowns because they can achieve similar epidemiological results but they also stimulate a substitution towards the formal sector that eases the drop of aggregate consumption.

Targeted transfers help reduce the negative impact of the pandemic on the income of the vulnerable population and, in this way, facilitate self-care measures for this population. However, these transfers also reduce the labor supply and, with it, the level of economic activity. Universal transfers stimulate aggregate demand and, in particular, generate a boost in formal consumption. Therefore, universal transfers generate an increase in the price of the formal good and positively affects the formality rate. Nonetheless, there is also a negative effect on the supply of informal labor, similar to the one produced by targeted transfers, not to mention their higher cost.

Regarding the differences between Peru and Colombia, first, informal goods have a higher share in the consumption bundle of Peruvian families and, for this reason, households are more prone to contagion. Second, the Peruvian labor market is less distorted and its reaction to a shock is likely to be faster. Finally, the transfers made to vulnerable households were relatively lower in Peru. These differences help understanding why Peru experienced a greater recession, despite having lower unemployment.

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