Pensions and informality in a structuralist dual-economy model

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Abstract

Latin American countries have successfully increased old-age protection in the last decades through non-contributory schemes of social pensions, though coverage is far from universal and the size of social pensions is very low. Moreover, half of the working age population is still outside of contributory pensions schemes due to high levels of labor informality, which casts doubts on the feasibility of achieving universal old-age protection in the region. The purpose of this paper is to assess whether social pensions can improve old-age protection, in terms of coverage and sufficiency, in countries with a large informal sector. I built a theoretical dual-economy model with three pension schemes, where social pensions are only one response to the old-age protection deficit, alongside with income sharing inside households and informal work by the unprotected old. It is shown that, with a demand-led formal sector, the government can set targets of sufficiency and full-coverage through social pensions, hence guaranteeing to the old the right not to work and reducing the burden on their families.

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1 Introduction

The state of old-age protection in Latin America reflects very well the progress, challenges, and dilemmas of social protection in developing countries. The region exhibits a relatively good performance when compared with other developing regions in the world (ILO, 2017), as three-quarters of the old-age population are covered by some form of pension (Arenas de Mesa, 2019). However, there is still one quarter of the population uncovered, and the size of benefits provided are quite low in most countries (Rofman et al., 2015).

The strong expansion of pension coverage in the region is mainly due to the implementation of subsidized, non-contributory schemes of *social pensions*: money transfers to the old-poor (Arenas de Mesa, 2019; Rofman et al., 2015). Although social pensions tend to be considered poverty-alleviation programs, they have become an important component of pension systems in Latin America, should these be broadly understood as mechanisms to provide income security to the old, to maintain an aggregate level of income, and to guarantee the right to not work after a certain age.

Pension systems are thus divided into non-contributory social pensions and contributory schemes, the latter in turn exhibiting different combinations of public Pay-As-You-Go and private Fully-Funded schemes. This is evidence of the infamous segmentation of social protection systems in the region—different schemes and programs aimed at different groups of people with different rules and benefits (Barrientos, 2019; Levy & Cruces, 2021).

Another segmentation, in labor markets and productive structure, is pervasive in the region: the existence of a large informal sector—a wide spectrum of precarious and unstable forms of work and production—alongside the formal one based on standard and regulated wage relations. Both types of segmentation—in social protection systems and the formal/informal divide in labor markets—are closely intertwined, since informal workers are not covered by contributory social protection schemes, so that non-contributory ones are created to include them.

The analysis of such *double segmentation* has been tackled mainly from the neoclassical approach, where there is a generalized idea that it is social protection segmentation which drives informality: malfunctioning social protection systems reduce incentives to formalization, while non-contributory schemes act as a subsidy to informality (Levy & Cruces, 2021). For these reasons, neoclassical authors tend to advocate for the restructuring of social pro-

tection through the reduction in benefits, the fine-tuning of incentives, and a greater role of private actors to guarantee efficiency and fiscal discipline; in the case of pensions, this imply the shrinkage of public PAYG schemes to re-direct public resources to the deserving poor in small and means-tested non-contributory schemes.

Nevertheless, the idea that informality is driven by ill-designed regulations can be criticized from the structuralist approach (Ros, 2013; Taylor, 1983), which has shown that dualism is determined by the productive structure and the macroeconomic constraints imposed by the subordinate position of peripheral countries in international markets. Such a different explanation of informality might lead to a different view of social protection policies in developing countries, but structuralist authors, mostly concerned with growth and macrodynamics, have not analyzed extensively the issue. Hence, it is worth studying fragmented social protection systems from a structuralist perspective, leaving aside the neoclassical ideas of informality as a matter of wrong incentives and fiscal discipline as the main criteria for social policy.

The purpose of this paper is thus to analyze, from a structuralist approach, the possibilities and implications of extending old-age protection through social pensions in countries with large informal sectors. I build a theoretical model where a segmented pension system is introduced into a structuralist dual-economy framework, using also some insights from the theory of social reproduction (Picchio, 1992), in which the domestic, economic, and political orders share the responsibility to guarantee dignified standards of living to the members of society. It aims to represent the situation of Latin American countries and contribute to the analysis of pension systems in terms of their ability to grant effective income protection to the elderly, and to shed light on the implications of different pension designs in these countries.

The paper is organized as follows: the second section discusses the state of old-age protection and double segmentation in Latin American countries; the third section reviews and discusses the theoretical insights in the modeling of dual economies; the fourth section introduces the basic structure of the model; the fifth section presents the short-run solution and explores its features; the sixth section analyzes the implications for pension policies; and the seventh section concludes.

2 Old-age protection and double segmentation in Latin American countries

Pension systems are a recurrent source of concern in Latin American countries, as they are expected to cause enormous social, political and fiscal pressures in the next decades. Population aging and financial sustainability are the main points to be addressed in discussions on pensions,[1] but there is another problem at the center of the unsatisfactory state of old-age protection in the region: segmentation.

On the one hand, pension systems are split among several schemes and regimes which are not always well harmonized, each covering different groups and operating under different rules. On the other hand, an important part of the population still has no access at all to old-age income protection. The lack of access to pensions is directly related to the high levels of labor informality, since workers with low and unstable incomes are not able to contribute to pension schemes during their working age, and hence have no right to a pension at the retirement age.

This is the problem of double segmentation, which dates back to the creation of Bismarckian social protection systems in the 20th century. Due to low administrative capacity and low tax revenues, social protection was initially granted to urban waged workers only, and its extension to the rest was trusted on the development process that were supposed to gradually move people into the urban formal sector (Kaplan & Levy, 2014). In the most advanced countries benefits were gradually extended to other groups, leading to very large and complex systems that became the target of pro-austerity reforms; most countries, however, kept their systems very small and exclusionary (Mesa-Lago, 2020).

The economic crises and the influence of the Washington Consensus led to a wave of structural reforms, starting with the privatization of pensions in Chile in 1981 under dictatorship. Other ten countries reformed their pensions later, during the 1990s and 2000s, but there the democratic process allowed for the influence of different interest groups and the inclusion of broader social demands (Arenas de Mesa, 2019; Mesa-Lago, 2020).[2] As a result, pension sys-

[1] The ECLAC predicts that the share of population aged 65 or more will grow from 9% in 2020 to 19% in 2050 in the region (https://statistics.cepal.org/), though Latin American countries are highly heterogeneous regarding the stage of the demographic transition they are in (González et al., 2021).

[2] The countries that made structural pension reforms are Argentina (1994, with a re-reform in 2008), Bolivia (1997, with a re-reform in 2010), Chile (1981, with a re-reform in 2008), Colombia (1994), Costa Rica (2001), Dominican Republic (2003), El Salvador (1998), Mexico (1997), Panama (2008), Peru (1993) and Uruguay (1996). Several parametric reforms have been made too in some of these and other countries.

tems in the region are highly varied, with different combinations of Pay-As-You-Go (PAYG) and Fully-Funded (FF) schemes, and different degrees of state involvement.

Following Mesa-Lago (2020) and Arenas de Mesa (2019), the contributory side of pension systems in Latin America can be broadly classified in four groups: 1) a public PAYG scheme of defined benefits (PAYG-DB) only; 2) a privately administered FF scheme of defined contributions (FF-DC) only; 3) mixed systems where a predominantly PAYG scheme is complemented by a FF one, and workers participate in both; and 4) parallel systems where PAYG and FF schemes compete for workers' contributions.[3]

There are other *non-contributory* pension schemes that were introduced or expanded in several countries during the 2000s, as part of a bigger wave of growth in cash-transfers-based social assistance (Abramo et al., 2019; Barrientos, 2019). These, also known as *social pensions*, were the main response to the problem of double segmentation. It became a widespread strategy to extend old-age protection to those left out of the contributory schemes, since it "could reach many people, involve relatively limited budgets, and enjoy popular support" (Arza, 2019, p. 25).[4]

As in the contributory case, there are several types of social pensions designs, but most operate as cash transfers targeted to the old that do not qualify, or are not eligible, for a contributory pension. The more used strategy is what Arza (2019) calls the *means-tested poverty relief* model: targeted pension benefits of relatively low size and coverage, in countries where the contributory schemes are also small and the informal sector is relatively large, "a pension coverage strategy that does not guarantee full coverage or adequate benefits, but which has expanded access to cash benefits among older adults considerably in some countries" (p. 36).[5]

[3]The purely public PAYG-DB system subsists in countries that never implemented structural reforms: Brazil, Cuba, Ecuador, Guatemala, Haiti, Honduras, Nicaragua, Paraguay, and Venezuela. In Argentina, a structural reform adopted the mixed system in 1993, but it was later reversed, with the FF-DC pillar nationalized and integrated into a unique PAYG-DB scheme. The purely private FF-DC system was pioneered by Chile in 1981 and later adopted by Bolivia, Mexico, El Salvador, Dominican Republic. Chile re-reformed its system in 2008 to integrate components of solidarity in a PAYG fashion, with public funding and administration in part; Bolivia also re-reformed the system nationalizing its administration but keeping the FF-DC design. Costa Rica, Panama and Uruguay have mixed systems, while only Colombia and Peru have parallel systems.

[4]According to Rofman et al. (2015), there were at least 14 countries that introduced reforms to create or expand non-contributory pensions: Argentina (2003), Bolivia (2008), Brazil (2006), Chile (2008), Colombia (2004), Costa Rica (2000), Ecuador (2006), El Salvador (2009), Mexico (2001), Panama (2009), Paraguay (2010), Peru (2008), Uruguay (2005) and Trinidad and Tobago (2010).

[5]This strategy operates in Colombia, Ecuador, El Salvador, Guatemala, Paraguay and Peru. Other types of social pensions are called by Arza (2019) the *contributory plus* model in Argentina, Brazil, Chile and Uruguay, where social pensions, with relatively high levels of benefits and coverage, are used to reach "close-to-full coverage" (p. 28) and complement already strong contributory schemes. There is also the *universal minimal* model in Bolivia and Mexico, where contributory schemes have low coverage and social pensions are granted universally, although

Thanks to these strategies, Latin American countries have expanded old-age protection in recent decades and exhibit rates of coverage that are relatively high when compared to other developing countries (ILO, 2017). Considering the active or contributors' rate of coverage—the ratio of pension contributors to total active population—there was an increase from an average of 34,8% in 2000 to 45,3% in 2017 (Arenas de Mesa, 2019). Despite the progress, contributory regimes are quite small, since more than a half of the current working population does not participate in a contributory scheme. The active rate of coverage is closely and negatively correlated with the size of labor informality, while positively correlated with the level of income and contribution density.[6] This suggests that it is low incomes and working instability what is preventing people from contributing to pensions in the region.

On the other hand, passive or recipients' coverage—the share of population aged 65 or more that receives a pension—passed from an average of 51,5% to 76,2% between 2002 and 2017. Most of this improvement comes from non-contributory schemes, whose coverage expanded from 3,8% to 22,7% in the same period, while contributory schemes passed from 48,1% to 55% (Arenas de Mesa, 2019).

Regarding *sufficiency*, apart from the countries with the strongest social protection systems (Argentina, Brazil, Costa Rica, Chile and Urugay), the benefits granted by social pensions in Latin America are very low: they are in general below the poverty line and represent a small fraction of pensions in contributory systems, 30% at best (Rofman et al., 2015).

Therefore, although social pensions have contributed to the expansion of coverage, old-age protection is still quite deficient in most Latin American countries. This is linked to the level of development and the size of the informal sector, since low and unstable incomes prevent people from contributing during their working age and qualifying for a pension when old.

The segmentation in labor markets is aggravated by a segmentation in pension systems, since social pensions tend to be considered more like social assistance programs for poverty alleviation, rather than integral parts of pension systems, and discussions on pension reforms are usually focused on the contributory side. Only the most advanced countries, like Chile and Uruguay, have integrated systems (Arenas de Mesa, 2019), but even there it is misleading to see social pensions as a residual segment for poverty alleviation: in Chile, for example, the reform of 2008 expanded the role of the state to guarantee a minimum pension through

with relatively low benefits. Rofman et al. (2015) provide a complete and detailed analysis of the experience of 14 Latin American countries with social pensions.

[6]Contribution density is the length of time during which contributions are made as a percentage of the total length of working life.

subsidies even to those in the contributory scheme, since pensions delivered by the private FF-DB scheme tend to be very low.

This casts into question the relation between labor markets, contributory schemes, and subsidized schemes. Low rates of active coverage respond to high levels of informality, but they can also be affected by the design of pension schemes, since it has been widely documented how the privatization turn failed to increase coverage despite reductions in informality (Arenas de Mesa, 2019; Mesa-Lago, 2020). On the other hand, there is a strong concern about the negative effects on formalization of non-contributory social protection programs, which are considered subsidies to informality and drivers of segmentation (Levy & Cruces, 2021; Melguizo et al., 2017). It is thus necessary to better understand the relation between labor markets and pension systems, comprising both contributory and non-contributory schemes.

3 Informality and pensions in economic models

Informality is an heterogeneous set of low-paid, unstable and insecure forms of work in small-scale and low-productivity activities, usually organized and operated by workers themselves with low costs of entry and capital needs. It includes the activities of street vendors, trash pickers, small family businesses, small scale commerce, domestic labor, unpaid labor, some forms of self-employment, and some forms of waged work that are typically insecure and unregulated. Although Latin American countries are highly heterogeneous in this respect, on average a 53% of the labor force was informal in 2019 in the region (ILO, 2020).

Informality is generally analyzed in multi-sector labor market models (Fields, 2005, 2011), where each sector exhibits different working and productive conditions; this framework can also capture the double segmentation referred to above, by including differences in access to social protection across sectors. To model the the existence and persistence of such differences a theoretical explanation of informality is necessary, but since it overlaps with underdevelopment, any such explanation is inescapably framed into a particular worldview of the development process itself.[7]

In this respect, there are two main approaches in economic theory. The *neoclassical* ap-

[7] As put by Ohnsorge and Yu (2021, p. 18), "informality is associated with poor economic outcomes." Countries with large informal sectors tend to exhibit lower per capita incomes and productivity; higher rates of poverty and inequality; lower levels of human capital and health outcomes; weaker states in terms of tax revenues, expenditure, administrative capacity, and quality of institutions; lower financial development and bad infrastructure; and weaker social protection systems.

proach understands informality as the result of individual optimal choices, whereas for the *structuralist* approach it has to do with the whole set of economic conditions and the productive structure of an economy, which determine the availability of good jobs. This dichotomy is present in diverse strands of literature, but I prefer to put it here in terms of neoclassical versus structuralist approaches, to stress the broader difference in worldviews of the economy and the development process, and to frame it in the history of economic thought.[8]

In the neoclassical approach the nature of informality is mainly *regulatory* or *juridical*. It is defined as any "legal economic activity taking place below the radar of government" (Oviedo et al., 2009, p. 3), or the "labor relations that occur outside the scope of regulation involving employment protection or [that] preclude the access to social security benefits" (Leyva & Urrutia, 2020, p. 1).

The stress here is put on the-non compliment with regulations, and the phenomenon to be explained is why some agents choose to not comply, the reason being that regulations are either exclusionary mechanisms or perverse incentives that lead people to choose informality. For example, labor and social protection norms increase the tax wedge and prevent firms from hiring low-productivity workers (Maloney, 2004), while the perceived benefits of formality are low when compared with some benefits of informality like better pay, flexibility, and access to targeted subsidized benefits (Oviedo et al., 2009). From this perspective, the segmented and malfunctioning social protection systems in Latin America are viewed as leading causes of informality (Kaplan & Levy, 2014; Levy & Cruces, 2021). This is compatible with the neo-institutionalist idea that underdevelopment is the result of bad institutions.

Some empirical findings justify this understanding of informality: the observed transitions of workers between formality and informality (Perry et al., 2007), the overlapping of wage distributions across formal and informal sectors (Maloney, 2004), and a tendency of formal-informal wage gaps to disappear after controlling for workers' characteristics (Ohnsorge & Yu, 2021). Hence, the neoclassical theoretical literature approaches the relation between social protection and informality as a problem of job search and matching, with social protection poli-

[8] In the context of neoclassical multi-sector labor markets models the dichotomy is captured by the existence or not of *labor market segmentation*, which in this case means a rationing of good jobs so that comparable workers earn different wages in different sectors; in turn, there is no segmentation when earnings are equalized after controlling for the characteristics of workers, who self-select into formality or informality. On the other hand, Perry et al. (2007) present the dichotomy in terms of *exit versus exclusion*: informality can arise either when workers and firms choose to *exit* the formal sector, or when some of them are *excluded* from the formal sector and forced to operate informally because formal jobs and productive processes are not available for everyone. The dichotomy can thus be interpreted as a matter of voluntary versus involuntary informality.

cies acting as frictions that alter the value functions of agents, while low-productivity workers and firms self-select into the informal sector (Meghir et al., 2015; Oviedo et al., 2009). In the specific case of pensions, McKiernan (2021) calibrates a model for Chile and finds that privatization increases welfare, mainly because it makes formal work more attractive through tax reduction, and because it increases capital accumulation through higher savings. In general, these models tend to obtain the usual supply-led neoclassical results.

However, these models still assume that formal jobs are somehow better or preferable, with frictions that prevent workers from getting them (Alonso-Ortiz & Leal, 2018; Meghir et al., 2015). Moreover, it is the availability of formal jobs and the growth in employment opportunities which ultimately limits the size of the formal sector (Basu et al., 2019). On the other hand, as stated by Fields (2005, p. 8), even if wage gaps reflect unobserved differences and there is some labor mobility across sectors, labor markets in developing countries "are better characterized as being segmented in the sense of cumulative advantage and low-level traps." This means that for most workers, most of the time, good formal jobs are not an option. It is thus necessary to explain why good jobs are scarce rather than just assuming that they are.

For the *structuralist approach*, in turn, informality is *functional*, defined in terms of the activities performed and the role they play in the whole economic structure.[9] Here informality is the set of low-scale and low-productivity economic activities that are driven by subsistence rather than for-profit reasons (Wang & Piesse, 2013). Their systemic importance lies in that, despite operating at the margins of the main circuit of capital accumulation, informality is *functional* as the *mode of existence* of the industrial reserve army, and a source of low-cost inputs and wage goods for the core capitalist activities (Godfrey, 1977).

The origin of multi-sector labor market models can be placed in this approach, with the notion of economic dualism by Arthur Lewis (1954). Dualism is the result of low capital-to-labor ratios in an economy, where capital is concentrated in a modern or formal sector while the rest of workers engage in close-to-subsistence economic activities. Therefore, the formal sector faces *unlimited supplies of labor* in the sense of a perfectly elastic labor supply (Ros, 2013). The two sectors are usually modeled as differing in terms of the commodities produced,

[9]This approach resonates with the concept of *structural heterogeneity*, from the Latin American Structuralist school of the thought in the ECLAC, which anticipated the notion of dualism by Lewis (1954) (Bielschowsky, 2009), and implies that informality is the result of a particular *economic structure* in the sense of Taylor (1983). Hence, I call this approach *structuralist* to stress the functional role of informality and to frame the analysis in these traditions of economic thought.

the technologies employed, and their objectives and organizational models (Wang & Piesse, 2013).

Theoretical models in the structuralist approach can take two forms. On the one hand, a general equilibrium analysis based on the Heckscher-Ohlin-Samuelson framework, where factor endowments and substitution mechanisms govern the interaction between sectors, and the results are presented in comparative statics or dynamics for short- or medium-run effects (Chaudhuri & Mukhopadhyay, 2010; Razmi, 2006). On the other hand, dual-economy growth models, where capital accumulation and aggregate demand play a stronger role, and results are presented in terms of steady-states for long-run implications (Dutt & Ros, 2007; Razmi, 2015; Ros & Skott, 1998; Taylor, 1983).

Although labor protection norms are included in some structuralist general equilibrium models (Chaudhuri & Mukhopadhyay, 2010; Razmi, 2011), and some heterodox growth models deal with pensions (Michl, 2007; Rada, 2017), social protection, and pensions in particular, have not yet been analyzed in the framework of structuralist dual economy models.

This is a task worth pursuing for several reasons. First, because the focus on growth and long-run trends of structuralism leaves it with little to say on social protection issues: it is either the outdated promise of a gradual and automatic expansion through the development process, or a generic support for social policies without a deep understanding of their effects. Second, because the issue of double segmentation—in labor markets and social protection—is a salient feature of developing countries that should be included in such analysis. Third, because structuralism considers alternative mechanisms behind informality, like aggregate demand effects and accumulation patterns, that should be explored to have a more complete picture than the purely regulatory view of neoclassical models. And fourth, because the nature of pensions may have interesting implications for the structuralist understanding of growth in dual economies, through intergenerational dynamics and the effects on savings and capital accumulation.

4 Set-up of the model

The most obvious and widespread way to model pensions is through overlapping generations (OLG). This framework allows to differentiate the population by age, to make working status depend on it, and to model the *intergenerational* transfer mechanism that any pension scheme ultimately is. Moreover, OLG allows to establish a link between the present and future conditions of the same generation, an *intertemporal* dimension that is relevant to analyze pensions,

especially fully funded schemes where current benefits depend on past contributions, but more importantly, it is necessary to address the problem of low pension coverage due to informality, since it is the lack of contributions during the working age what determines the lack of a pension after the retirement age.

The OLG framework has some drawbacks too. It forces the model to be in discrete time, and in analytical, schematic models the different cohorts are actual generations, so that the period of analysis is very long, of around 30 years. Hence, static solutions cannot be said to be short-run, and the usual assumption that state variables are given for the current period is not very realistic. Moreover, it is a standard assumption that different generations are of equal size, so that demographic structure and changes, relevant to analyze pensions, are hard to incorporate in a realistic way. However, in a first step to incorporate pensions in an analytical dual-economy model, the OLG framework is the simplest way to do it.

It is assumed that there are two generations of young and old people that live for two periods. Both generations are assumed to have the same size equal to 1, so that total population is constant, of size 2. This implies that monetary values can be interpreted as representing per-young (or per-old) person magnitudes. This assumption is made without loss of generality to ease notation, but it excludes any analysis of aging and demographic changes, which is not the main objective herein.[10]

The age threshold is given by the mandated retirement age, but to get retired workers must participate in a contributory pension scheme and only those employed in the formal sector can do it. Hence, in any period t all formal workers are young by definition, the size of the formal labor force is denoted L_{F_t}, and the retirees of contributory pension schemes are the young formal workers of the previous period, $L_{F_{t-1}}$. Note that, since the size of each generation is 1, L_{F_t} is actually the share of formal employment among the young, and $L_{F_{t-1}}$ is the share of formal pensioners among the old. In terms of pensions, such shares are respectively the active rate of coverage and the passive rate of coverage of contributory schemes.

The informal sector is different. Young workers who cannot find a formal job must work in the informal sector. Moreover, since young informal workers will not have a contributory pension, some of them will have to keep working when they get old; this is captured by the parameter ϵ_t: the fraction of old people without a contributory pension—those who were young

[10]The model could be extended to deal with aging by introducing a survival rate for the young, hence making the size of the old generation a fraction of the young one, like in Cipriani (2013) and Stauvermann and Kumar (2016), although endogenizing aging and demographic changes is far more complex.

informal workers in period $t-1$—that keep working when they get old. Thus, there are both young and old informal workers. The share of informal employment among the young is $(1-L_{F_t})$ and the share of elders without a contributory pension is $(1-L_{F_{t-1}})$. The total size of the informal labor force is, in turn:

$$L_{I_t} = (1-L_{F_t}) + \epsilon_t(1-L_{F_{t-1}}) \tag{1}$$

Total population is thus divided in four groups: i) *formal workers* or the *formal young*; ii) *retirees* or the *formal old*; iii) the *informal young*; and iv) the *informal old*. These are respectively the four terms in the right-hand side of the population identity:

$$2 \equiv L_{F_t} + L_{F_{t-1}} + (1-L_{F_t}) + (1-L_{F_{t-1}})$$

Per-person disposable incomes will be denoted by $h^y_{F_t}$ for the formal young, $h^o_{F_t}$ for the formal old, $h^y_{I_t}$ for the informal young, and $h^o_{I_t}$ for the informal old. Hence, total disposable income of working-class households is:

$$H_t = h^y_{F_t}L_{F_t} + h^o_{F_t}L_{F_{t-1}} + h^y_{I_t}(1-L_{F_t}) + h^o_{I_t}(1-L_{F_{t-1}})$$

In line with models in the structuralist tradition (Dutt & Ros, 2007; Ros, 2013; Ros & Skott, 1998; Taylor, 1983), economic duality is defined in terms of the organization, technologies and objectives of production. The formal sector is capitalist, produces a commodity that is both a consumption and a capital good, and employs labor and capital under a Leontieff technology with fixed coefficients and constant returns to scale. In any period, capacity is taken as given—not necessarily at the normal rate—and the formal sector is Kaleckian in that it accommodates demand by adjusting the capacity of utilization u_t. Hence, output and employment in the formal sector are demand-determined. Denoting labor productivity by $1/z$, the stock of capital at the beginning of period t by K_t, and assuming the desired or normal rate of capacity utilization—the normal output to capital ratio—equal to 1, formal sector output and employment are given by:

$$Y_{F_t} = \frac{L_{F_t}}{z} = u_t K_t \tag{2}$$

The formal sets prices according to a constant mark-up over labor costs. The price of the formal good is assumed fixed and equal to 1, the real product wage w_t is taken as given in the current period, and there is no inflation.[11] Hereafter, all values in real terms can be considered as deflated by the price of the formal good. Assuming that the government collects sales taxes at the rate τ_F, the profit rate is given by the following equation, where π is the profit share.

$$r_t = (1 - \tau_F - z w_{F_t})\, u_t = \pi u_t \tag{3}$$

The informal sector, in turn, is characterized by low scale and self-employment activities with low costs of entry. It produces a service that can be used only for consumption, and employs only labor with a given productivity x and constant marginal returns. Informal output is given by:

$$Y_{I_t} = x L_{I_t} \tag{4}$$

Informal workers earn a real wage equal to xP_t, where P_t is the price of the informal sector commodity, that can also be interpreted as the relative price or the terms of trade between the two sectors. The informal sector is competitive and adjusts through changes in P_t. In other words, given that informal output is supply constrained by the lack of capital, and by definition it employs the whole informal labor force, the adjustment can occur only through prices.

The dual character of the economy here represented requires some buffering mechanisms in the broader sense of the theory of social reproduction by Picchio (1992). According to her, the attempts by capital to externalize the costs of social reproduction generate parallel forms of work, production and exchange that are necessary for people to meet their needs and for social stability to be maintained. Social protection plays an important mediating role in this process (Théret, 2006), but so does informality, in the Classical sense of Lewis (1954), since it absorbs all the (young) workers excluded from the formal sector.

Given that old-age income protection is a key element of social reproduction (Saritas Oran,

[11] Inflation dynamics is an important element of developing countries, but it is not treated because the focus here is on the short-run. On the other hand, wage setting is a very important topic in dual-economy models of informality, which can alter the dynamic implications and the sheer existence of the informal sector (Brown, 2015; Fields, 2005, 2011; Wang & Piesse, 2013). However, Ros (2013) shows that simple assumptions on wage setting, like that the formal sector wage is just a premium over the informal sector wage, can give interesting results, an assumption that in any case is not controversial for a short-run analysis. Here it is assumed that the formal real wage is given in any period, maybe set by a bargaining process at the beginning of the period.

2017), a malfunctioning pension system that cannot guarantee dignified conditions of living to the elderly generates different responses by the political, domestic and economic orders: the government provides subsidized social pensions; the old engage in productive activities themselves to earn a living; and households play a greater role in old-age protection, through non-market carework, stronger family ties, and intrahousehold transfers.

The first mechanism was discussed in the second section when describing the non-contributory schemes of social pensions in Latin America. Here it is modeled by assuming that the government grants a subsidized pension of size s in real terms to a fraction φ of the unprotected old. Total household income coming from social pensions is thus $s\varphi(1 - L_{F_{t-1}})$.

The other responses are clearly illustrated by Arza (2019) for Latin American countries., through an index of old-age protection that combines the coverage and sufficiency of pensions, in both contributory and non-contributory schemes. She shows that lower levels of old-age protection are correlated with higher rates of old-age participation in the labor force, and with lower incidence of independent living among older adults.

The first response implies that the buffering role of informality works also for the elderly in a way that expands the Classical Lewisian mechanism: it not only absorbs those excluded from formal jobs, but also part of those uncovered by contributory pensions. In this sense, informality is a way for households to cope with the exclusion implied by double segmentation, rather than a cause of it as in the regulatory approach of Levy and Cruces (2021), Maloney (2004), and Perry et al. (2007). In the case of pensions, it is an intertemporal Lewisian mechanism captured by ϵ_t, the fraction of the old non-covered by contributory pensions that work in the informal sector, shown above in Equation 1. Using this, and the informal real wage defined above, the total income per-person received by the informal old is given by:[12]

$$h^o_{I_t} = xP_t\epsilon_t + s\varphi \tag{5}$$

The second response identified by Arza (2019) points to the buffering role of families, which is modeled by assuming income-sharing inside households. This is a standard assumption in the modeling of informality since Lewis (1954), whose idea that informal wages are determined by the average—instead of marginal—product of labor is interpreted as a form of

[12]This expression is also the expected income of the informal old, where ϵ_t and φ are the shares of the informal old that work and receive a social pension respectively, while xP_t and s are the informal wage rate and the size of social pensions respectively.

wage sharing. Also Razmi (2015) and Razmi et al. (2012) use the concept of work sharing in the presence of underemployment to define the average income of the informal sector as the informal wage divided by the sum of informal labor and unemployment;[13] they use this average informal income as a reservation wage that affects the wage bargaining process in the formal sector, so it can be rather interpreted as the expected income of those losing their formal jobs.

Here, on the contrary, I consider income sharing as a mechanism used by families to support their members when they happen to work in informality or do not have a contributory pension; intrahousehold solidarity between old and young generations thus works in both directions, in line with the evidence that pensions and old-age transfers have a positive impact on household security and children's well-being (Abramo et al., 2019).

The modeling of intrahousehold solidarity requires a more detailed specification of their composition: first, households are assumed to have one young member and one old member;[14] second, the working status of young and old members of the household are taken as independent events.[15] With these assumptions it is possible to represent the total, pooled income of a household with an informal old member as the expected income of such a household: the income of an informal old, plus the weighted sum of formal and informal young incomes, the weights being the proportion of formal and informal workers in the young generation: $h^o_{I_t} + h^y_{F_t} L_{F_t} + h^y_{I_t}(1 - L_{F_t})$.

Finally, a minimum level of real income per household Ψ is introduced, a level of *subsistence* income in the sense of the Classical approach,, where it is "understood with reference to norms and habits that are socially and historically determined, not merely in terms of the bare necessities of survival" (Stirati, 1994, p. 35). The minimum level of income also reflects the claim by the theory of social reproduction that a certain level of material conditions must be assured for society to endure (Picchio, 1992). It is defined in real terms, hence in terms of the formal sector good, which also implies that, even though the economy is dual and segmented,

[13]Work-sharing means that not only income but also work is pooled in the informal sector, so that it comprises a variety of forms like underemployment, self-employment, irregular employment, non-remunerated work, and even unemployment. Hence, although unemployment is not introduced explicitly as a separate segment in the labor market this is not a full-employment model. It is important to stress that the non-working informal old are better considered as inactive, due to their age and health conditions, rather than unemployed.

[14]Since the size of total population equals 2, the model can be interpreted to be on a per-household basis.

[15]This means that the probability of a young person being formal or informal is not affected by the their parents being formal or informal during their youth. This is a strong assumption in the context of Latin American countries, where intergenerational mobility is far from being guaranteed and poverty is in a large extent hereditary, but the assumption is useful to facilitate the analysis and as a first approximation to the issue.

all members of society are dependent on the capitalist relations of production and must recur to the formal sector to meet their needs. Hence, informality is functional in the Marxist sense of Godfrey (1977), in that it expands the market for the formal sector goods.

The participation of the old poor in the labor market is assumed to be the buffering mechanism through which households can assure this minimum level of income when no other option is available. To model this, the expected income of a household with informal old members is equated to the minimum level Ψ and solved for ϵ_t, which, using Equation 5, is thus given by:

$$\epsilon_t = \frac{\Psi - s\varphi - h^y_{F_t} L_{F_t} - h^y_{I_t}(1 - L_{F_t})}{xP_t} \tag{6}$$

It is now time to describe the workings of contributory pension schemes. In any period t, a fraction γ of young formal workers contributes to the PAYG scheme and a fraction $(1-\gamma)$ contributes to the FF scheme. Retirees are entitled to a pension benefit from the scheme they contributed to when young. The contribution rate α acts as a tax on labor income and is the same for both schemes. The total size of pension contributions is thus given by the following identity, where the first term of the right-hand side are the contributions going to the PAYG scheme and the second term are those going to the FF scheme:

$$\alpha w_t L_{F_t} \equiv \gamma \alpha w_t L_{F_t} + (1-\gamma)\alpha w_t L_{F_t}$$

The PAYG scheme collects contributions from young workers and uses them to pay its retirees a pension in the same period, assumed to guarantee a replacement rate b of previous wages. The total size of pension benefits paid by the PAYG scheme is thus $\gamma b w_{t-1} L_{F_{t-1}}$. Assuming that the PAYG scheme is balanced, in period t the value of contributions equals the value of pensions paid:[16]

$$\alpha\gamma w_t L_{F_t} = \gamma b w_{t-1} L_{F_{t-1}} \tag{7}$$

[16]Since both the contribution rate α and the replacement rate b are policy-determined, the PAYG scheme lacks of an automatic stabilizer that guarantees its financial equilibrium. The adjustment usually falls on the government, which absorbs any non-zero difference between contributions collected and pensions paid. This is the main concern when discussing the financial sustainability of PAYG schemes, which can be "fixed" through either parametric reforms—one-time changes in α, b, or retirement age—or a PAYG scheme with notional accounts—endogenizing the replacement rate b so that it depends on contribution history, hence α—or structural reforms towards a FF scheme. Since this is not the main concern of the paper, and the analysis will be static, I assume that the PAYG scheme is balanced: parameters α and b are set so that equation 7 holds.

The FF scheme is assumed to be already in operation.[17] In any period t, pension funds collect contributions from workers and use them to buy physical capital.[18] The stock of capital owned by retirees through pension funds is denoted by K_t^R, and its share in the total stock of capital is denoted by ρ_t:

$$\begin{aligned} K_t^R &= \alpha(1-\gamma)w_{t-1}L_{F_{t-1}} \\ \rho_t &= \frac{K_t^R}{K_t} \end{aligned} \tag{8}$$

Retirees' capital stock is lent to formal sector firms and yields the profit rate r_t. Pension funds receive the returns and buyback the capital stock, and transfer all the proceeds to retirees as pensions. Thus, the size of pension benefits paid by the FF scheme is

$$(1+r_t)(1-\gamma)\alpha w_{t-1}L_{F_{t-1}} = (1+r_t)K_t^R \tag{9}$$

And the financial balance of pension funds is given by

$$\Delta K_{t+1}^R = (1-\gamma)\alpha w_t L_{F_t} + r_t K_t^R - (1+r_t)K_t^R \tag{10}$$

Besides pension contributions formal workers also pay a tax on labor income at the rate τ_H. Using equations 7 and 9, it is now possible to fully specify the per-person incomes of the four population groups ($h_{F_t}^y$, $h_{F_t}^o$, $h_{I_t}^y$, and $h_{I_t}^o$), and the total disposable income of working class households (H_t):

$$\begin{aligned} h_{F_t}^y &= (1-\tau_H-\alpha)w_t \\ h_{F_t}^o &= \left[\gamma b + (1-\gamma)(1+r_t)\alpha\right] w_{t-1} \\ h_{I_t}^y &= xP_t \\ h_{I_t}^o &= \epsilon_t x P_t + s\varphi \end{aligned} \tag{11}$$

[17] This precludes any analysis of the transition from a fully PAYG scheme, which, as pointed out by Cesaratto (2006), has important implications for assessing the effects of aging and the comparability of PAYG and FF schemes. It also implies that pension schemes cannot have an impact on aggregate savings (Cesaratto, 2007), as is usually argued by advocates of FF schemes.

[18] In practice, pension funds invest in a wide range of financial assets which include public debt and foreign assets, so not all of the pension savings end up financing capital accumulation in the country. However, in this model of a closed economy without government debt and no financial sector the only asset is real capital. It is a simplification also used by Cesaratto (2007), Michl (2007), and Rada (2017), when the finacialization implications of FF pension schemes are not the main topic of analysis.

$$
\begin{aligned}
H_t =& h^y_{F_t} L_{F_t} + h^o_{F_t} L_{F_{t-1}} + h^y_{I_t}(1 - L_{F_t}) + h^o_{I_t}(1 - L_{F_{t-1}}) \\
=& (1 - \alpha(1 - \gamma) - \tau_H) w_t L_{F_t} + (1 + r_t) K^R_t \\
&+ x P_t (1 - L_{F_t}) + (\epsilon_t x P_t + s\varphi)(1 - L_{F_{t-1}})
\end{aligned} \tag{12}
$$

It is assumed that workers do not save and capitalist do not consume, so total disposable households' income equals aggregate consumption. Consumption functions are:

$$
\begin{aligned}
C_{F_t} &= \theta(P_t) H_t \\
P_t C_{I_t} &= (1 - \theta(P_t))\, H_t
\end{aligned} \tag{13}
$$

Where $\theta' > 0$ implies that the commodities of both sectors are gross substitutes, with a non-infinite constant elasticity of substitution.

The government collects taxes from the formal sector only, at rates τ_F, τ_H and τ_K respectively for the taxes on sales, labor income, and capital income (retirees exempted). Total government revenue T_t is used to pay for social pensions, so government budget is balanced.

$$
T_t = \tau_F Y_{F_t} + \tau_H w_t L_{F_t} + \tau_K r_t K^C_t = s\varphi(1 - L_{F_{t-1}}) \tag{14}
$$

Finally, the investment function of the formal sector contains only an accelerator mechanism: assuming no depreciation, capital accumulation for the next period is proportional to the current level of output in the formal sector, so all investment is induced.[19]

$$
I_t = \Delta K_{t+1} = a Y_{F_t} \tag{15}
$$

Such an "investment function should not be taken to imply that actual output is equal to capacity output" (Cesaratto et al., 2003, p. 42), nor that capacity is at its normal level: output is demand-determined and there is a slow adjustment overtime of capacity to effective demand and of utilization to its normal level. Since here the analysis is limited to the static equilibrium, I assume that capacity utilization is given—not necessarily at the normal level—and that the formal sector is demand-led, with production being accommodated by utilizing more of the existing capacity.

[19] This type of investment function is used in *supermultiplier* growth models, with growth driven by autonomous demand and capacity utilization converges to its normal level in the long-run (Freitas & Serrano, 2015).

Table 1: Social Accounting Matrix

	Expenditures							**Invest-ment**	**Σ**
	Formal sector	Informal sector	Workers	Capi-talists	Govt.	PAYG	Pension Funds		
Income									
Formal sector			C_{F_t}					I_t	Y_{F_t}
Informal sector			$P_tC_{I_t}$						$P_tY_{I_t}$
Workers	$w_tL_{F_t}$	$xP_tL_{I_t}$			$s\varphi(1-L_{F_{t-1}})$	$\alpha\gamma w_tL_{F_t}$	$(1+r_t)K_t^R$		H_t^{BT}
Capitalists	$r_tK_t^C$								$r_tK_t^C$
Government	$\tau_FY_{F_t}$		$\tau_Hw_tL_{F_t}$	$\tau_Kr_tK_t^C$					T_t
PAYG			$\gamma\alpha w_tL_{F_t}$						$\alpha\gamma w_tL_{F_t}$
Pension funds	$r_tK_t^R$		$(1-\gamma)\alpha w_tL_{F_t}$						$r_tK_t^R + K_{t+1}^R$
Savings				ΔK_{t+1}^C			ΔK_{t+1}^R		ΔK_{t+1}
Σ	Y_{F_t}	$P_tY_{I_t}$	H_t^{BT}	$r_tK_t^C$	T_t	$\alpha\gamma w_tL_{F_t}$	$r_tK_t^R + K_{t+1}^R$	ΔK_{t+1}	

Given that the stock of capital is split between retirees and capitalists, $K_t = K_t^R + K_t^C$, the savings-investment identity, implied by the whole set of macroeconomic identities, shows that investment by capitalists is equal to their net income, which is all saved:

$$\Delta K_{t+1}^C = I_t - \Delta K_{t+1}^R = (1 - \tau_K) r_t K_t^C$$

The Social Accounting Matrix in table 1 shows the previous set of identities and relations between the sectors of the economy, and ensures that the model is stock-flow consistent.[20]

5 Equilibrium

As it was stated before, the static, one-period equilibrium in OLG models cannot be properly called a short-run one because the time-lapse of a generation is of around 30 years. It will be called instead a one-period equilibrium, in which the state variables of the model, the stock of capital and the real wage in the formal sector, are taken as givens.

In this section the one-period equilibrium is presented and its properties analyzed, assuming that social pensions follow a policy of "sound finance:" given tax rates and government revenues, social pensions' parameters s and φ are set to guarantee a balanced budget; this resembles the way that Latin American governments have approached social policies in recent years. Such baseline scenario is modified in the next section, where coverage and sufficiency criteria are imposed on social pensions, assuming that the adjustment falls on tax rates.

The one-period equilibrium is characterized by the simultaneous clearing of both commodity markets, so the following two conditions must be satisfied:

$$\begin{aligned} Y_{F_t} &= C_{F_t} + I_t \\ P_t Y_{I_t} &= P_t C_{I_t} \end{aligned} \tag{16}$$

By using the consumption functions in Equations 13, the market clearing conditions together imply:

$$Y_{F_t} - I_t = H_t - P_t Y_{I_t} \tag{16'}$$

[20] In the Social Accounting Matrix H_t^{BT} denotes working class household incomes before taxes and contributions, which is equation 12 but using w_t instead of $h_{F_t}^y$.

and substituting here Equations 2, 15, 12 and 4, one arrives at:

$$Y_{F_t}(1-a) = (1-\alpha(1-\gamma)-\tau_H)w_t L_{F_t} + (1+r_t)K_t^R + s\varphi(1-L_{F_{t-1}})$$

Dividing this equation by the stock of capital K_t, and after some algebraic manipulations, the expression for the one-period equilibrium rate of capacity utilization is:

$$u_t^* = \frac{\rho_t}{\alpha(1-\gamma)zw_t + (1-\tau_F - zw_t)(1-\tau_K)(1-\rho_t) - a} \tag{17}$$

This expression is equivalent to the savings-investment identity and exhibits the standard form for the determination of output in demand-led models: an autonomous component (ρ_t) times a multiplier (the inverse of the denominator). The autonomous component is the share of capital owned by retirees, and is autonomous here in the sense of being predetermined: the contributions made in the previous period to the FF scheme. It is the purely dissaving component of pensions, and enters here as a determinant of the utilization capacity since it is entirely spent on consumption.

The informal sector seems to have practically disappeared from the determination of output levels in the formal sector, even though informal workers' income is also a source of demand for the formal good. However, it is still present. Note from Equation 16', that, in the aggregate, since the informal sector uses only labor and distributes all income to workers who do not save, the informal sector spends what it produces in value terms, even if everyone consumes a composite basket of the two commodities. This attests the buffering role of the informal sector, since those excluded from the formal one end up producing for their own living in parallel circuits of production and exchange.

The only informal income that has an effect on formal sector output is the one originated outside of the informal circuit: social pensions. The presence of taxes in the multiplier of 17 is because they finance social pensions, $s\varphi(1-L_{F_{t-1}})$. Taxes contribute to aggregate demand via the consumption of the old, both formal and informal, in line with the argument by Lorente (2019, p. 421, translation is mine) that "the aim of the pension system is to maintain a flow of income."

A finite value for the utilization rate requires a strictly greater than zero denominator in 17, which expresses the standard Keynesian stability condition for the propensity to save to be

higher than the propensity to invest, and which is assumed to hold.

The two first terms in the denominator represent the propensity to save. On the one hand, $\alpha(1-\gamma)zw_t$ are the contributions of workers to the FF pension scheme, and hence proportional to formal labor income zw_t. The other terms in the propensity to save represent capitalists' savings, which are equal to their income net of taxes and depend on their share in the total stock of capital, hence proportional to $(1-\tau_K)(1-\rho_t)$; the negative effect of sales taxes τ_F and wages zw_t on capitalists savings is because they reduce the profit share (Equation 3).

The denominator shows that the effect of taxes on formal sector output comes strictly from capitalists income: taxes transfer income from capitalists, with a propensity to save equal to 1, towards pensioners of the PAYG and the non-contributory scheme, with a propensity to save equal to 0, and hence increase aggregate demand. Taxes on labor income do not appear since they are a transfer between groups with the same propensity to consume, so they cancel out.

All this implies that the effect of social pensions on formal output depends on how it is financed. Taking partial derivatives, and denoting by m the multiplier (the inverse of the denominator in Equation 17), the effects of taxes on sales and capital income are respectively:

$$\frac{\partial u_t^*}{\partial \tau_F} = (1-\rho_t)(1-\tau_K)mu_t > 0$$
$$\frac{\partial u_t^*}{\partial \tau_K} = (1-\rho_t)\pi mu_t > 0$$

This shows that the relative effect of both types of taxes depends on the relative size of the reciprocal of taxes on capital and the profit share, since those are the bases on which each tax is levied. As stated above, taxes have a stimulative effect only because they fall on capitalists' income, which is $(1-\tau_F-zwt)(1-\tau_K)(1-\rho_t)u_t$. Hence, sales taxes tend to have a higher stimulative effect when taxes on capital are low, because they are applied on a higher base. In turn, taxes on capital income may have a lower effect because they are applied on a base, the profit share, from which not only sales taxes but also labor income are deduced.

The effect of contributory pension schemes can be seen from the partial derivatives of Equation 17 with respect to the rate of pension contributions, α, and the share of the PAYG scheme on them, γ, which are respectively:

$$\frac{\partial u_t^*}{\partial \alpha} = -(1-\gamma) z w_t m u_t < 0$$
$$\frac{\partial u_t^*}{\partial \gamma} = \alpha z w_t m u_t > 0$$

The rate of pension contributions has a negative effect because it increases savings through the FF scheme, while the share of the PAYG scheme has a positive effect because it redistributes income simultaneously, in the same period, between generations. The role of the share of retirees' capital in the numerator and the effect of the share of PAYG contributions in the multiplier suggests that a mixed pension system with both types of regimes could be appropriate. However, in a broader setting with other sources of autonomous consumption like government spending and exports, the role of retirees dissaving as a source of current consumption could be less important, while a higher share of the PAYG scheme would increase its multiplier effects.

The other endogenous variable to be determined in the one-period equilibrium is the relative price of the informal sector commodity, P_t, which clears the market of this sector. Pulling Equations 4 and 1 into the second equilibrium condition, and using the consumption functions 13 and 16', one arrives at:

$$\frac{P_t \theta(P_t)}{1-\theta(P_t)} = \frac{(1-a) Y_{F_t}}{x[(1-L_{F_t}) + \epsilon_t (1-L_{F_{t-1}})]} \tag{18}$$

Since the left-hand side is increasing in P_t, Equation 18 can be intuitively interpreted: the denominator shows that P_t rises with a higher formal sector output, Y_{F_t}, because this implies higher incomes and higher demand for the informal sector commodity; in turn, the numerator shows that P_t falls with higher informal labor supply and productivity, because this increases informal output. However, the effects are more complex since, first, formal output determines as a residuum the level of informal employment, and second, the share of working informal old, ϵ_t, is affected by the two endogenous variables u_t and P_t.

To explore more deeply the relation between the two sectors through P_t, first note that the left-hand side of Equation 18 is a function $\Theta(P_t)$ such that:

$$\Theta(P_t) = \frac{P_t \theta(P_t)}{1-\theta(P_t)} = B P_t^{\beta}$$

Where B is a constant and β is the elasticity of substitution between the two commodi-

ties.[21] Using this, total differentiation of 18 yields:

$$\frac{dP_t}{du_t} = \frac{P_t}{u_t} \cdot \frac{L_{I_t} + L_{F_t} - u_t\epsilon_u(1 - L_{F_{t-1}})}{\beta L_{I_t} + P_t\epsilon_P(1 - L_{F_{t-1}})}$$

Where the partial derivatives ϵ_P and ϵ_u are, from Equation 6:

$$\epsilon_u = \frac{\partial \epsilon_t}{\partial u_t} = \left[1 - (1 - \alpha - \tau_H)\frac{w_t}{xP_t}\right] zK_t = -\mu zK_t < 0$$
$$\epsilon_P = \frac{\partial \epsilon_t}{\partial P_t} = -\frac{(1 - L_{F_t}) + \epsilon_t}{P_t} < 0$$

The second equality in the equation for ϵ_u follows from denoting by μ the formal-informal wage premium, so that $h^y_{F_t} = (1+\mu)h^y_{I_t}$. Combining the three equations above one arrives at an expression for the elasticity of the relative price with respect to the rate of capacity utilization:

$$\eta_{P,u} = \frac{L_{I_t} + (1 + \mu)L_{F_t}(1 - L_{F_{t-1}})}{(\beta - 1)L_{I_t} + (1 - L_{F_t})L_{F_{t-1}}} \tag{19}$$

The elasticity $\eta_{P,u}$ will be positive in general for $\beta \geq 0$, provided that the informal sector exists, $L_{I_t} > 0$. Low values of β can make $\eta_{P,u}$ to be negative, unless the size of the informal labor force is sufficiently large. In the special case of Cobb-Douglas preferences, with $\beta = 1$, it is necessary the existence of current-period informality ($L_{F_t} < 1$) and previous-period formality ($L_{F_{t-1}} > 0$). It is plausible to assume that the two commodities are gross substitutes: informal workers are greatly concentrated in sectors like commerce and other non-tradeables which can compete with similar commodities produced by the formal sector but that are not identical. Hence, a general assumption in this kind of models is $\beta \geq 1$, which, with persistent coexistence of the two sectors, implies that $\eta_{P,u} > 0$; the intuition above of a positive effect of the rate of capacity utilization on the relative price can thus be assumed.

The total effect of u_t on P_t can be decomposed in five effects, the first two already mentioned above: 1) a demand effect, because higher utilization increases formal income, which stimulates demand for the informal sector commodity; 2) a labor supply effect, since higher utilization means a higher absorption of young labor by the formal sector, hence lower labor supply and output in the informal sector; 3) an old-labor-supply effect from income sharing,

[21] It can be shown that, assuming a generic CES utility function $(b_F C_{F_t}^{\beta_0} + b_I C_{I_t}^{\beta_0})^{1/\beta_0}$, optimization under the budget constraint H_t yields relative consumption demands such that $\theta(P_t)/(1 - \theta(P_t)) = BP_t^{\beta-1}$, where $B = (b_F/b_I)^{\beta}$, and $\beta = 1/(1 - \beta_0)$ is the constant elasticity of substitution.

coming directly from u_t, when higher formal incomes are shared with the informal old, allowing them to reduce their labor supply; 4) an old-labor-supply effect coming indirectly from the informal income effects of u_t on P_t, when an increase in P_t rises informal incomes and hence allows the informal old to achieve the minimum level of household income with less work; and 5) a consumption-substitution effect, when changes in relative prices induce changes in consumption patterns, altering the results of income and labor supply effects above.

Therefore, the buffering mechanisms introduced above—income sharing and labor supply of the informal old—affect the sectoral interlinkages through the relative price.

These effects can be identified in Equation 18. The first effect is, interestingly, captured by the first term in the numerator, the total informal labor force L_{I_t}, because the effect is in the form of an elasticity. Note from Equation 18 that L_{I_t} is the ratio of formal sector consumption to the function $\Theta(P_t)$; in other words, L_{I_t} is proportional to the ratio u_t/P_t. Intuitively, when the informal labor force is large, the informal commodity price is relatively low, so that increases in demand arising from higher formal sector incomes will produce proportionately bigger rises in the relative price.

The second term in the numerator, the formal-informal labor income ratio $(1 + \mu)$ multiplied by the share of formal-young/informal-old households, embodies the second and third effects above: a rise in u_t increases formal employment, hence putting upward pressure on P_t through lower informal labor supply; moreover, higher formal employment means a higher share of households where informal parents are supported by their young formal relatives; higher formal incomes are spread to the un-protected old, which allows them to work less and enhances the lower informal labor supply effect on P_t. Therefore, a higher share of this type of households and a higher formal-informal wage premium result in a higher price-utilization elasticity.

The fourth effect—higher prices increase informal income and thus reduce the labor supply of the old—appears in the denominator. It is embodied in the negative sign of L_{I_t}, which is composed both of young and old workers: a higher P_t increases the income of the informal old directly, through their own work, and indirectly, through income sharing when they happen to live in a household with young informal relatives. That is why such income effect is proportional to the whole informal labor force. Note, however, the last term in the denominator, the share of informal-young/formal-old households: a higher share of this type households implies a lower share of informal-young/informal-old households, which reduces the income

effect of higher P_t on the informal old labor supply through intrahousehold income sharing; that is why this term appears with a positive sign in the denominator.

Lastly, the effect of substitution in consumption is captured by the elasticity of substitution β multiplying the total informal labor force in the denominator. The substitution mechanism means that a higher price P_t reduces the demand for the informal sector commodity, and hence weakens the upward pressure on the relative price. The higher β, the strongest the substitution effect will be, so the responsiveness of P_t to u_t will be lower. This effect is proportional to the total informal labor force since, as was stated above, the informal sector earns what it consumes; in other words, it is informal income what counts for the working of the substitution mechanism.

6 Pension policies

Having discussed the general functioning of the model we can now turn to analyze the policy options concerning the pension system, in particular the non-contributory scheme of social pensions.

The main policy instrument here is $s\varphi$, the size of the subsidized pension, s, multiplied by the share of the informal old who would receive it, φ. It embodies the two main evaluation criteria for pension systems: sufficiency and (passive) coverage respectively. Since the focus here is not on the contributory side, it is assumed that formal retirees in PAYG and FF schemes are fully covered and receive a sufficient pension benefit, although in practice this is not necessarily true.

Parameters s and φ can be discretionary set by the government, and in practice they are. However, following efficiency and fiscal discipline reasons, countries tend to set s at very low levels, well below the poverty line and contributory pensions (Rofman et al., 2015), while φ is mostly based on means-testing targeting mechanisms (Arza, 2019). In this sense, $s\varphi$ can be thought to be somewhat "endogenous", correlated with the level of development and fiscal capacity (Arenas de Mesa, 2019).

The set-up of the model above represents such scenario: social pensions do not appear in the expression for the capacity utilization in Equation 17, since they are substituted by the tax revenues that finance them. It can be interpreted that the government sets the tax rates and let $s\varphi$ to be determined by what it can collect.

An alternative policy choice requires setting more concrete targets for $s\varphi$. The purpose here is to analyze the implications of quite generous social pensions designs, with targets of full coverage and sufficiency, so it is hereafter assumed that $\varphi = 1$ (full coverage). Regarding sufficiency, there are two alternative policy targets in the context of this model. One option is to set them to guarantee a minimum level of income to the informal old, $\bar{s}$; since Ψ is the minimum level of income per household compatible with social reproduction, and the old are one half of a household, it can be assumed that $s = \Psi/2$.

Note that, in any case, households already obtain the minimum level of income, thanks to the working decisions of the informal old, so the final effect of social pensions will be seen on this decision. Under the target $s = \Psi/2$, the share of working informal old will be:

$$\epsilon_t = \frac{\Psi}{2xP_t} - (1 + \mu L_{F_t}) \tag{T1}$$

Setting social pension benefits at the minimum level of income is no guarantee of well-being for the elderly, in the sense of having the right to not work, since household income can still be insufficient if informal young relatives earn a very low wage. The government can thus target $\epsilon_t = 0$, which implies that the size of social pension benefits must be:

$$s = \Psi - xP_t(1 + \mu L_{F_t}) \tag{T2}$$

The last target is hard to achieve in practice, because ϵ_t is an endogenous variable that depends on the two adjusting variables of the model, u_t and P_t. It can be seen in Equation T1 that the participation of the old in the labor force increases with high levels of informality among the young (low L_{F_t}, and hence low u_t), and decreases with higher informal wages xP_t. Therefore, this last equation must be interpreted as the required level for s that guarantees $\epsilon_t = 0$, rather than a policy decision on the value of s.

In other words, the government cannot target directly the actual well-being of the informal old, since it depends on general economic conditions, which shows how informality affects policy outcomes. The government can do its best, however, by targeting full coverage and sufficiency. To explore its effects, the total amount of social pensions can be thus taken as constant and redefined, in proportion to the beginning-of-period stock of capital, as

$$\sigma = \frac{(\Psi/2)(1 - L_{F_{t-1}})}{K_t}$$

The equilibrium level of capacity utilization is different with an exogenous σ. After some manipulations of Equation 16', it can be shown that:

$$u_t^* = \frac{\rho_t + \sigma}{[\alpha(1-\gamma) + \rho_t]\, z w_t + (1 - \rho_t) + (\tau_H z w_t + \tau_F \rho_t) - a} \tag{20}$$

There are two big differences with respect to the baseline scenario of Equation 17, where social pensions was endogenous follow a policy of sound finance. First, now social pensions appear in the numerator, as an autonomous source of demand; second, the denominator is slightly changed, since now it is taxes on labor and pension incomes that appear. It does not mean that taxes on capital are not needed anymore, they just do not appear directly because they are implicit in σ: it can be considered that taxes on capital income are endogenously adjusted to finance social pensions, although they do not need to be the only source of funding, also sales and labor income taxes contribute, but they adjust in a different way, through changes in u_t. It is similar to the Keynesian mechanism by which, with a given propensity to save, aggregate income adjusts to equate total savings with total investment. Here, with given tax rates, aggregate income adjusts to allow for the intergenerational transfers implied by σ.

In any case, σ has a positive effect on the equilibrium level of capacity utilization, so it can be considered to generate its own funding through the Keynesian multiplier effect. This means that tax revenue and fiscal discipline should not be considered as constraints for a program of social pensions to the unprotected old in the presence of informality.

As for the effects in the informal sector, σ would appear both in the numerator and in the denominator of the right-hand side of Equation 18: social pensions would put upward pressure on the relative price of the informal sector through both demand and supply channels: since σ stimulates u_t, it increases the demand for the informal sector commodity, and since σ lowers ϵ_t, it reduces total informal labor supply. Hence, social pensions would have a positive effect too on informal sector incomes.

Finally, one can explore the effects of a social pension policy that manages to bring $\epsilon_t = 0$. By denoting D_t the denominator in Equation 20, and using T2, the utilization level compatible with zero participation of the old in informal labor is:

$$u_t^0 = \frac{\rho_t + (\Psi - xP_t)/K_t}{D_t + xP_t\mu z} \tag{21}$$

In turn, the relative price of the informal sector under T2 can be found by pulling u_t^0 and $\epsilon_t = 0$ into Equation 18:

$$\Theta(P_t^0) = \frac{1-a}{x} \cdot \frac{K_t^R + \Psi - xP_t^0}{D_t - z[K_t^R + \Psi - (1+\mu)xP_t^0]} \tag{22}$$

A social pensions policy that totally eliminates the need to work for the old would radically alter the functioning of an economy with informality. First, it will make the rate of capacity utilization depend negatively on the relative price of the informal sector commodity, as can be seen in Equation 21: now, instead of the total amount of social pensions, it is the difference between the minimum level of household income and the informal wage what appears as the second component of autonomous demand, while the denominator is expanded (hence the multiplier is reduced) by formal-informal wage premium. Intuitively, a higher informal wage will allow for a reduction in social pensions, that would have a negative effect on u_t.

On the other hand, the relative price of the informal sector is now independent of the level of capacity utilization, as can be seen in Equation 22. Such a policy thus stabilizes informal sector incomes and lets the adjustment fall on the formal sector.

7 Conclusions

In this paper, a pension system with three schemes is introduced into a dual-economy model, to analyze policies of social pensions in developing countries with a large informal sector.

Three main conclusions can be drawn from the exercise herein. First, with a demand-led formal sector there is not a fiscal constraint that can prevent the government from providing social pensions to the informal old, with targets of sufficiency and full coverage. This because social pensions will act as an autonomous component of formal sector demand, hence stimulating that sector. This can be done by taxing the income of capitalists, which means transferring resources from a class with zero propensity to consume to another class with zero propensity to save (in the extreme case of this model). Here the capital income tax can be considered the endogenous policy instrument, although more resources can be drawn from taxes on sales and labor income, whose revenue will adjust endogenously, too, through the Keyensian demand-

led mechanism of a higher level of activity.

The second conclusion is that, despite the fiscal feasibility of social pensions, the government cannot target directly the welfare of the informal old through social pensions. Here welfare is understood as the right to not working after a certain age, which is what a pension system is about. In an economy with informality and income sharing inside the household, the old are forced to work when household incomes reach an unacceptable low level, an outcome that depends on the overall functioning of the economy and not only on social pensions. However, given the positive effect of capacity utilization on the relative price, it can be thought that social pensions will eventually guarantee the right to not work to the informal old, since the positive effect on utilization will increase the relative price and hence informal labor income. However, there are other elements at play, like the formal-informal composition of households and the elasticity of substitution between the two commodities, which suggest that this mechanism cannot be taken for granted.

In the third place, it was shown that the design of contributory pension schemes can affect the outcomes of the non-contributory side through their effects on formal sector level of economic activity. On the one hand, a FF scheme is necessary because it provides an autonomous source of demand (the dissavings of past contributions), but, on the other hand, the PAYG scheme amplifies the multiplier mechanism of aggregate demand, so it has a positive effect on the self-funding feature of social pensions, while it helps also to amplify their effects on aggregate demand. With other sources of autonomous demand, the role of a FF scheme seems to be less relevant, so the preferred policy mix would be a universal scheme of social pensions plus a predominantly PAYG non-contributory side.

The analysis here is, however, quite schematic and incomplete. On the one hand, it should be extended to the long run, to analyze the dynamic implications of the model and explore the evolution of informality over time, including the effects that different pension systems can have on it. On the other hand, other elements should be included in the model: balance of payments effects and inflation dynamics, because of their importance for developing countries, and also the financial sector, given the importance of public debt and capital markets for the functioning of pension systems.

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