Modeling functional and juridical informality: a guide for data-driven policy

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ABSTRACT
This paper reviews a methodology for integrating the informal sector into social accounting matrices and a simple computable general equilibrium model. Two theoretical models are developed to show how this can be done. The models differ according to whether the presence of the informal sector is due to capital limitations, *functional* informality, versus *juridical* informality, which may arise as an illegal or quasi-legal competitive strategy that runs the risk of state sanctions. The goal is to offer to policymakers some perspectives on how the informal sector could be incorporated into the economy without first repressing it in a way that inhibits its transformation.

KEYWORDS
Informal sector, Functional, Juridical, Employment, Social Accounting Matrices, Computable General Equilibrium Models, Phase transition.

JEL CLASSIFICATION
C15, C68, D58, E26, O17, O21

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1. Introduction

The informal sector is often criticized as an economic second class citizen, both with respect to productivity and real wages, as well as working conditions and compliance with labor and environmental standards.[1] Setting aside the normative critique of informality for the moment, this paper focuses on how the informal sector can be included objectively in a social accounting matrix (SAM) and associated macroeconomic models. When properly accounted for, it is seen that the informal sector adds to GDP, stimulates *formal* sector output and employment and generally contributes to economic well-being. This conclusion is inescapable when one quantifies the presence of the informal sector in a formal model and examines various counterfactuals with respect to its size and modes of interaction with the formal economy. It follows that using legal or juridical means to suppress the informal sector will likely be counterproductive to the goals of those who seek to eliminate it.

Gibson and Flaherty (2016b) develop a theoretical framework for analysis of the informal sector, solidly grounded in fundamental economic concepts. The distinction between *functional* and *juridical* informality is developed, based on Gibson and Flaherty (2016b). It is argued there that informal sector *workers* rarely choose informality and would prefer formal sector employment were it available. Informal shop *owners*, however, may elect to avoid labor and environmental standards as a competitive strategy, but this is not *functionally* informal according to Gibson and Flaherty (2016b). Legally, however, these firms are unquestionably informal and may not be registered or even counted in the

[1]For a legal and statistical overview of the concepts of informality and non-standard employment see ILO (2018). See Gibson and Flaherty (2016b) for a review of some of the recent literature.

economic censuses or national income and product accounts (NIPA). This is *juridical* informality according to Gibson and Flaherty (2016b).

The literature on informality occasionally takes the position that despite years of growth and trade in the globalized economy, "informality stubbornly persists" (Sinha, 2011). A direct implication of the juridical/functional distinction is that growth and trade will *not* necessarily put an end to *all* informal activity. If functional informality persists, however, it is only because growth in the formal sector is insufficient to eliminate it. Juridical informality is another matter entirely. It may persist long after the economy is fully developed along most dimensions.[2]

The economic rationale for functional informality is simply that informal workers have no other option than to operate production processes that are "defective" in the sense that they would not be operated by formal sector firms (Gibson and Kelley, 1994). If the latter were required to pay the market rate for formal labor, profit might well sink below the market rate or even become negative. In this sense, the process of production is inoperable and would be abandoned by any formal sector firm. Informal sector producers take prices as given by the formal sector and formal sector producers take quantities as a residual, net of what the informal sector sells. Functional and juridical informality can be empirically distinguished by their comparative statics: a rise in aggregate demand, for example, will not typically cause an expansion in employment for both the formal and informal sectors if informality is functional. On the other hand, a rise in demand can cause formal and informal employment to rise simultaneously if the informality is juridical.

The paper is organized as follows: section 2 discusses in greater depth the distinction between functional and juridical informality.[3] Section 3 develops a simple model of functional informality and section 4 examines the phase transition to a purely formal economy. Section 5 develops the CGE model and provides numerical examples as a guide for how this might be done. Discussion of the implications of the difference between functional and juridical informality for the results of the models is presented in section 6. Section 7 draws conclusions from the study.

2. Functional and juridical informality

While there is little agreement on precisely what the informal sector is, there is no disagreement about the fact that it is *large*. The literature on the topic stretches back to Lewis (1954), who identifies an agricultural "traditional sector" that today would be called an "informal" economy. More than half of non-agricultural employment in the developing world is informal by one definition or another. Definitions range from the purely *juridical* "informal sector participants pay no taxes", to the more theoretical "the informal sector operates processes of production that do not return the average rate of profit when factors are paid their marginal products" (Gibson and Kelley, 1994). In between, there are definitions that depend on the nature of the product and its global supply chain, the conditions of work, and the overtly political "reserve army of unemployed" conception in which informality allows capital to more ruthlessly exploit labor. To locate the approach of this paper in the main strands of argument on informality, it is useful to elaborate on the two central explanations of the origins and persistence of informality. The Lewis view, a labor surplus model, typically is associated with the notion that informal work is inferior to formal. The key assumptions are low productivity in the informal sector and a general preference for formal work. Due to scarcity of opportunities in formal activities, workers are effectively excluded, involuntarily, which leads to a chronically stagnant and poverty-stricken informal sector, dragging down economy-wide average productivity and growth (Bangasser, 2000; Rand and Torm, 2012). [4] GDP growth

[2] Gibson (2012) provides an agent-based model that explores the conditions under which the informal sector persists or disappears.

[3] Readers unfamiliar with SAMs might want to consult the extensive literature on SAMs. To see in greater depth how SAMs are constructed and used in simple CGE models see Gibson and Flaherty (2016a).

[4] See also Portes and Schauffler (1993) for discussion of the PREALC/ILO analysis of informality as a survival mechanism.

and expansion of formal sector jobs are the solution to informality.

In contrast, the regulation view of informality instead explains informality as a flight from oppressive and costly regulation of formal activity. Informality then is an opportunity for those who voluntarily exit the formal sector for a more favorable cost structure. From this perspective, informality can be dynamic and productive, with incomes comparable to those in the formal sector (Bromley and Wilson, 2018; deSoto, 1989; Hart, 1973; Maloney, 2004; Perry et al., 2007; Wilson, 2011). If transition to formality is still the desired policy objective, reduction of the costs of formalizing must be reduced.

Neither view by itself can capture the complexity of informality, which is very heterogeneous and variable across institutional contexts. To map this empirical reality onto the labor surplus and regulation explanations, informality typically is divided into two segments, each of which exhibits the characteristics of one or the other explanations. Associated with the Lewis model is a segment variously identified as involuntary informality, exclusion from formality, low tier earnings or salaried informal work. Workers in all of these cases must remain unwillingly in the lowest paid, most uncertain and lowest skill informal activities. Associated with a regulation theory of informality is voluntary exit from formality and participation in informal work, high tier income and self-employment. The definitions of this segment capture the presence of informal activities that can be preferred to formal sector by virtue of earnings, working conditions or preferences for independence.

None of these distinctions is completely satisfactory in categorizing differences among those engaging in informal activities. Dividing informality into self-employed versus salaried work, as done in Fields (2004); Losby et al. (2002), the first defined as high tier and the second low, cannot address the condition of an independent worker who is a petty trader barely earning a subsistence income (Nordman et al., 2016). Moreover, firm size is often used as an indicator of self-employment or salaried work (Thomas, 2002). This is highly misleading in that it misses the increasingly important case of a large firm operating some informal processes or evading some formal regulations. [5]

Not only are these distinctions insufficient to define clearly overlapping segments of informality, their applicability varies widely across countries. Maloney (2004), for example, finds that the majority of informality in Mexico is voluntary, but for other Latin American countries the opposite holds. Because the analysis is derived from data on worker preferences, the institutional context drives the result in ways that further muddy the waters in segmenting informality.

This paper engages the discussion of informality and its heterogeneity also based on two distinct segments. The first, juridical informality, is largely a matter of choice or strategy, while the second, functional informality, does not involve meaningful choice. *Juridical informality* is defined by the legal structure of the economy, and *functional* informality is related to the dynamics of capital accumulation and the demand for labor. [6]

To this extent, the starting point aligns in spirit with the several distinctions described above. However, the foundation of the juridical/functional segmentation is very different. It is grounded in the underlying economic processes at work in low income countries, rather than the outcomes of those processes like differences in earnings, firm size or whether the work is self-employment versus salaried. The advantage of this categorization is its ability to focus on the fundamental causes of functional informality.

The key concept for defining functional informality is a defective process, which implies that production processes used by informal workers would fall into disuse if the employer had to pay proper wages and benefits (Gibson and Kelley, 1994). Functionally informal firms are capital-limited in that they lack sufficient access to capital markets to borrow enough to compete head-to-head with a formal sector that produces the same good. They amount to a competitive fringe.

In particular, informal firms and workers must be price takers. They must be sufficiently agile to meet the price set by the formal sector for their output. A rise in formal sector productivity that is passed along to consumers, for example, must be immediately countered by a fall in the informal price, whether productivity in

[5] Concerning the link between size and productivity or earnings, Amin and Islam (2015) dispute the common assertion that smaller informal firms are necessarily less productive than large.

[6] In a similar fashion, Ray (1998) separates functional from ethical or moral problems associated with poverty and income inequality.

the latter has increased or not. As price takers, informals are entirely at the mercy of the formal sector pricing structure.[7]

This does not mean, however, that informals are powerless. Just as they are price takers, the formal counterparts are "quantity takers" in that formal sector firms can do little to drive the informal sector out of the market. This is simply because functionally informal firms and workers are not in the sector by virtue of choice or calculation; they participate out of necessity and cannot remove themselves simply because formal sector productivity has risen.

Figure 1 illustrates the fundamental duality of the analysis of functional informality with the informal sector as a price taker and the formal sector as a quantity taker. The upward sloping supply curve in the left panel is the marginal cost of the formal firm, S_f. The market price is determined by the intersection of the net demand for the formal sector,$Q_d - Q_n$, determined as a residual after the informal sector has sold all its output at formal price p. Note that the marginal cost of the formal sector is equal to price, but the cost does not include the fixed quantity produced by the informal sector. The latter is given by the quantity of resources available to the informal sector to produce its output. The demand for informal output is infinitely elastic as shown in the right-hand panel. As an approximation, it is assumed that fixed coefficients production functions are at play here, with S_n in the right hand panel of figure 1 vertical. There is no marginal cost curve because the output of the sector can only increase with entry of more informal sector workers.

Note that the supply curve in the left-hand panel of figure 1 implies that the formal sector is itself in a competitive market structure. In this case, a unit increase in the output of the informal sector that could result from an additional informal producer, will reduce the output in the formal sector. With the upward sloping marginal cost (supply) curve, the marginal cost falls, and therefore the price as well. This adjustment mechanism implies that informal sector incomes fall for all informal producers, including the new entrant, since the informal sector takes its price from the formal sector. Formal sector employment will fall as well, and is treated in more detail below.

3. A simple model of functional informality

To proceed, let there be two sectors, formal and informal. The level of output in each sector is denoted by Q_i and is given by

$$Q_i = \mathcal{A}_i K_i^{\beta_i} L_i^{(1-\beta_i)} \tag{1}$$

where $i = 1, 2$ for the formal and informal sectors respectively. Here, $\mathcal{A}_i$ is an arbitrary calibration constant, K_i is the capital stock and L_i is the labor employed in each sector. The elasticity of output with respect to capital is β_i. In this model of functional informality, labor is a binding constraint and is written

$$\bar{L} = \sum_{i=1}^{2} L_i + L_s \tag{2}$$

where $\bar{L}$ is the labor supply, L_i is the *minimum labor* required to produce the output, Q_i, and L_s is the amount of *surplus labor* in the informal sector. Equation 2 is key in that it imposes "full employment" in the sense that workers are employed either in the formal sector *or* in the informal sector, either as necessary or surplus labor there. Following Lewis (1954), the *real wage in the formal sector*, w/p, is determined by the *average product* in the informal sector, including surplus labor

$$\frac{w}{p} = \frac{Q_2}{L_2 + L_s}. \tag{3}$$

[7] If products produced by the formal and informal sectors are not perfect substitutes, then a price difference may well arise. In what follows, the assumption of perfect substitutes is invoked for simplicity.

The fundamental equation of the model is then obtained by setting this real wage equal to the marginal product of formal labor, the first-order condition for profit maximization

$$\frac{dQ_i}{dL_i} = (1-\beta_i)\frac{Q_i}{L_i} = \frac{Q_2}{\bar{L}-L_1}, \tag{4}$$

which can be expressed in implicit form as

$$f(L_1) = (\bar{L}-L_1)/L_1^{\beta_1} - Q_2/(1-\beta_1)\mathcal{A}_1 K_1^{\beta_1} = 0 \tag{5}$$

Equation 5 is transcendental in the variable L_1, taking the level of output in the informal sector, Q_2, as given. A numerical approximation to the root is given below as for varying levels of informal sector output, Q_2.

Figure 2 shows the results from the informal equation for three increasing levels of output of the sector, $Q_2 = 53, 84$ and 125. Each curve crosses the horizontal x axis at a value of L_1 (the root) that satisfies the informal equation 5. If output in the informal sector is, for example, 84, the level of formal employment is 50. A rise in output to 125, however, will cause the real informal wage to increase, reducing the level of employment in the formal sector to 30. This is an irony of economies with large informal sectors for which foreign aid programs, for example, increase the productivity of the informal sector. The real wage in the informal sector increases, raising the real wage in the formal sector and driving formal employment, L_f, down. The rise in the wage requires a rise in the marginal productivity of labor in the formal sector, which in turn requires a *reduction* in the level of employment there.

The adjustment mechanism in the model proceeds as follows. Taking the level of Q_2 as given by some base line, an historically driven productivity metric, the informal equation 5 can be used to solve for the level of employment in the formal sector, L_1. Using equation 2, the total amount of labor left in the informal sector is then determined, and by way of equation 3 the real wage is known. The minimum employment in the informal sector, L_2,is determined by the marginal productivity condition, equation 4, and equation 2 subsequently allows a solution for the level of surplus labor, L_s. The first-order condition in the *informal* sector

$$(1-\beta_2)\frac{Q_2}{L_2} = \frac{Q_2}{\bar{L}-L_1} \tag{6}$$

can be used to compute the minimum labor, L_2, required to produce the given output there and subsequently the level of surplus labor. This gives the full specification for the model in the short run.

If the formal and informal sector capital stock is fixed in the short run, the only way in which the formal sector can increase employment is if the wage rate falls according to equation 4. One way this could occur is through population growth or in-migration from neighboring states to raise $\bar{L}$ and in turn increase surplus labor, L_s, in the informal sector. The increase in surplus labor has no bearing on the level of output Q_2, under the given assumptions; therefore, the *average* product in the informal sector falls. This causes additional labor absorption in the formal sector, as the real wage of formal labor falls and formal firms increase output as a result.

As seen in figure 2, *a rise in the output* of the informal sector, brought about by perhaps a foreign aid program or some autonomous shock of technical change, would encourage a *reverse* flow of workers from the formal to the informal sector. This perverse adjustment would continue until sufficient labor exited from the formal sector to bring about a rise in the marginal product of labor there. This is precipitated, of course, by the rise in the real wage. At the same time, the initial increase in informal sector wages would be eroded, according to equation 3, as previously formal workers joined the informal sector.

Without an additional inflow of labor, there is no way output in the formal sector can increase absent some form of technical change or capital accumulation. The presence of the informal sector effectively blocks the ability of formal sector firms to hire more labor. The existence of the informal sector thus hems in the normal market mechanism that would otherwise aid in bringing about higher levels

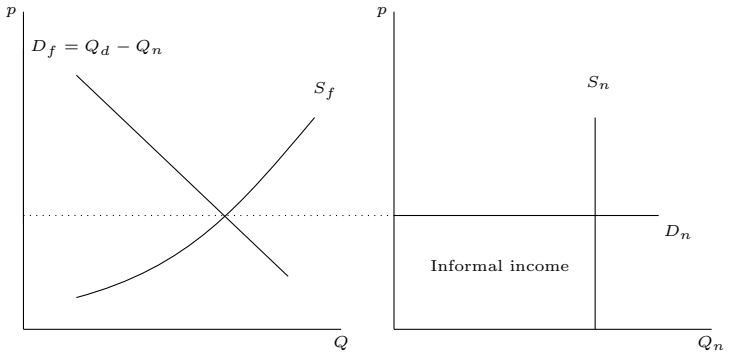

Figure 1. Functional informality

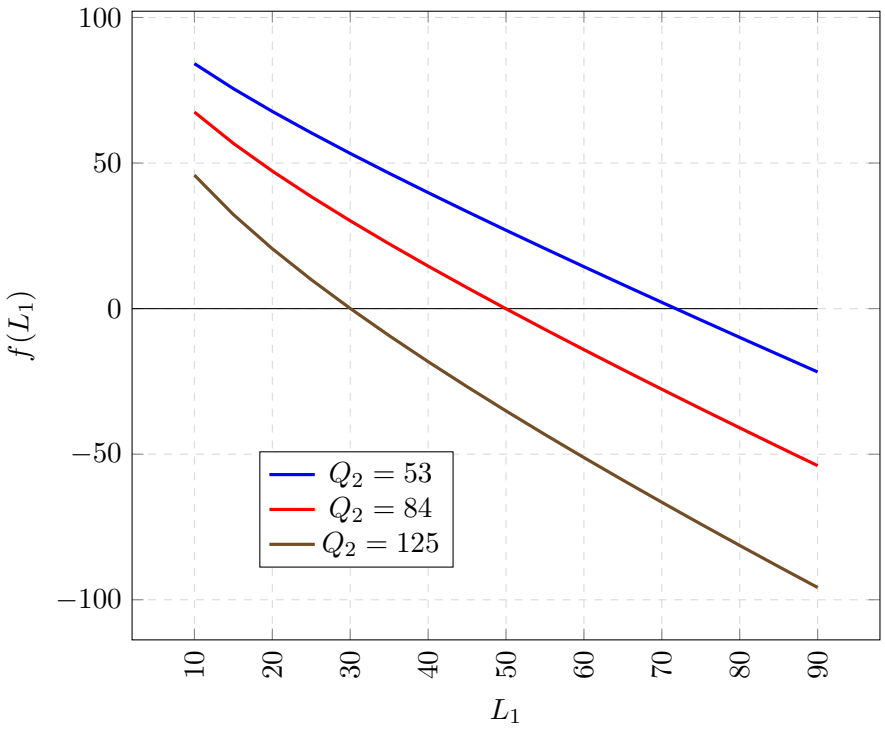

Figure 2. Roots of equation 5.

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of employment. Before one can conclude that this argument supports a policy stance against the informal sector, keep in mind that *were the informal effectively suppressed*, the market-clearing wage would necessarily be *lower* than what workers could earn on their own informally, according to the assumptions invoked above. Since the marginal product of labor would be lower than in the informal sector, total output would *fall*.[8]

3.1. The phase transition from functional to juridical informality

As the value of L_s goes to zero, the model experiences a *phase change*, with the Q_2 as the order parameter that drives the system. The rising real wage thus *opposes* the progression toward the phase transition; if somehow it could be held constant, informality would disappear more quickly. The phase change implies that all defective production processes disappear and all production processes in the economy become effectively formal. They can now pay the market wage rate and still return the average rate of profit. These sectors are no longer functionally informal. All workers are paid their marginal product and are indifferent as to whether they are employed in either sector. Juridical informality, however, can still easily exist at or beyond this turning point.

3.2. Income distribution

As formal capital accumulates, output in the formal sector rises, but output in the informal sector remains constant. Thus, GDP has risen, formal employment has risen, as has the quality of jobs. Average productivity in the informal sector has increased and certainly economy-wide productivity, GDP per worker, has improved. The transition to an all-functionally-formal economy is a welcomed development and serves to outline a path in which output, productivity and employment grow, while income distribution improves.

How is this last point seen in the context of the model presented here? In a model with only two income classes, the Gini coefficient is equivalent to the *difference* between the share of labor (both formal and informal) in the population, *less* the share of income of the same in total, economy-wide, income.[9]

To illustrate, consider the opposite problem of how in-migration *worsens* the distribution of income. Begin with an increase in the inflow of workers, δL. With no capital accumulation or technical change in the formal sector, all newcomers will become surplus labor. Thus, the share of the total population that workers represent increases. If this share of workers rises but the share of worker income in total income remains constant, the Gini coefficient will rise necessarily.

The share of worker income in total income depends on what happens to the share in both sectors, formal and informal. In the formal sector, the Cobb-Douglas technology guarantees that even if employment changes, the share of labor will remain fixed. On the other hand, if the size of the available labor force increases, Q_1 *cannot remain fixed*. Formal employment will indeed change since the real wage in the informal sector will fall with the new influx of migrants. Theorem 1 shows that in fact, the Gini will rise. A second theorem, Theorem 2, establishes that the level of employment rises.[10]

3.3. Dynamics of informality

The formal-informal sector model can be adapted to a dynamic framework to capture long-run effects. Formal sector dynamics are provided by the standard equation of capital accumulation for the state variable K_{1t}, the capital stock in the formal sector.

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[8] In developed economies the rise in leisure would have to compensate this fall in output. In developing economies, this makes little sense.

[9] If the share of income is the same as the share of population of workers, the Gini is zero and income is equally distributed.

[10] See the online technical appendix for formal statement and proof of these theorems.

Table 1. A SAM for the functionally informal model[a]

	Formal	Informal	Consum-ption	Invest-ment	Total
Formal	-	-	83.5	16.5	**100**
Informal	-	-	50	-	**50**
HH	100	50	-	-	**150**
Value added	-	-	-	-	-
Labor-Formal	70	-	-	-	**70**
Labor-Informal	-	50	-	-	**50**
Capital	30	-	-	-	**30**
Savings	-	-	16.5	-	**16.5**
Total	**100**	**50**	**150**	**16.5**	-

[a]- = N/A. Millions of LCUs.

Source: Authors' computations.

$$K_{1t} = K_{1t-1}(1-\delta) + I_{t-1} \tag{7}$$

where the t is the time subscript, δ is the rate of depreciation and I_{t-1} is investment in the previous period. Equation 7 links one period to the next but within each period, equation 5 can be solved to distribute labor between the formal and informal sectors. The quantity of surplus labor can then be computed for each period. The model requires a data base in the form of a SAM and from there it is possible to compute the path from an initial condition to the functional/juridical turning point.

Here Table 1 presents the formal/informal SAM to which a dynamic model with functional informality is calibrated. There are two sectors, formal and informal. First note that with the nominal wage rate equal to 1, the number of formal workers, $L_1 = 70$. With a labor force $\bar{L} = 120$, the remaining labor is in the informal sector, so that equation 2 is satisfied with $L_2 + L_s = 50$. Since output in the informal sector is $Q_2 = 50$, the wage in equation 3 is $Q_2/(L_2 + L_s) = 1$. The share of output in the formal sector that accrues to capital is $\beta = 0.3$ and from the production function in equation 1 the capital stock must be

$$K_1 = (Q_1/L^{1-\beta_1})^{1/\beta_1} = 230$$

In table 1 the GDP, computed as the sum of value added in both sectors, is 150. Investment *by origin* is 16.5 million LCUs and is added to the capital stock in the formal sector.[11]

4. Phase transition in the model of functional informality

In addition to the data of the SAM, additional parameters must be specified as shown in table 2. The settings for the first simulation are simple and although somewhat unrealistic, are designed to reveal the principal adjustment mechanisms of the model as clearly as possible. There is no growth in either the labor force or the output of the informal sector. Half of formal sector profits are invested in the capital stock of the formal sector. The capital stock of the informal sector remains constant. Table 3 shows the results of simulation for 30 periods.

Surplus labor is shown in the first column of table 3 and from the data of the table, it is evident that the economy exhausts its informal sector surplus labor by

[11]The distinction between *origin* and *destination* is necessary in multi-sectoral models. The former is a component of aggregate demand whereas the latter changes the capital stock by sector, according to equation 7.

Table 2. Basic parameter settings

	Sim 1 (%)	Sim 2 (%)	Sim 3 (%)	Sim 4 (%)
Depreciation[a] (δ) rate	5.0	5.0	5.0	5.0
Savings rate out of profits[b] (s)	0.50	.50	0.50	0.50
Rate of growth of informal output Q_2	0.0	0.02	0.0	0.0
labor force growth	0.0	0.001	0.0	0.0[c]
Technical change ($\mathcal{A}$) growth	0	0	0	0.5[3]
Share of capital β_1 formal	0.3	0.3	0.3	0.3
Share of capital β_2 informal	0.2	0.2	0.2	0.2
Initial capital stock formal[b]	230	230	230	230
Initial capital stock informal	60	60	60	60
Labor supply[b,c]	120	120	120	120

[a] Parameters *not* calibrated from SAM. [b]. From the base SAM.

[c] With wages = 1.

Source: Authors' computations based on illustrative data.

period 22. The decline proceeds at a rate of 15 percent per year. Thereafter, the economy is *all* formal with the two sectors still producing the same good, but with different formal processes[12] No "defective" process is in operation.

Column 3 of the table 3 shows the formal capital stock, which is growing at a rate of 1 percent in response to the 50 percent of profits that have been reinvested in the capital stock. The rate of depreciation slows the rate of capital accumulation in the formal sector, which in turn reduces the demand for labor that pools in the informal sector. Formal sector capital stock thus takes pride of place in determining the rate at which the economy approaches the turning point, from formal/informal to all formal.[13]

With Q_2 given, the next two columns of table 3 *simultaneously* determine the level of output, in column 5, and employment, in column 8, in the formal sector. The Lewis equation (equation 5) in column 7 determines the ratio of employment in the two sectors, but this depends on the quantity of formal output in column 5, Q_1, which in turn depends on L_1, the quantity of formal labor. With formal labor known, *total* informal labor is also determined (not shown) as just the difference between the labor supply and total formal labor.

4.1. A defective process in the informal sector

Splitting this quantity of labor into that required for the production of informal output, Q_2, and surplus labor, L_s, requires some effort but is highly instructive. Functionally informal labor, as defined here, is the quantity of labor *beyond the quantity of labor necessary for the formal production of* Q_2. Thus, it is necessary to define how much labor would be required to produce Q_2 formally, by way of the production function in equation 1. Taking the level of Q_2 and K_2 as *given*, the level of L_2 is then computed in column 9. Note that this level of labor is *not* consistent with the first-order condition of equation 4. The production process employed in the informal sector is thus *defective* in that profit is not non-negative if the average wage were paid, as it would be in the formal sector. In order to produce the level of output in column 6, with the capital stock in column 5, the labor demand in column 9 would require a real wage of 0.8[14] This wage is 20 percent *lower than the real wage determined by the average product in the informal sector*, shown in column 11. The process employed in the informal sector is therefore *defective*. If the average product in the informal sector were paid entrepreneurs producing Q_2

[12]The capital stock in the previously informal sector is lower, set at 60, and the share of profits is also lower, $\beta_2 = 0.25$.

[13]Here the reference is to functional informality; juridical informality, as noted above, can persist after the turning point.

[14]This is obtained by setting equation 4 to w, the required wage, and then solving for L_2, setting $Q_2 = 50$ and $K_2 = 60$.

formally, the rate of profit would fall to that shown in column 14 and the process would be abandoned. This is the meaning of "defective" as used in this paper.

4.2. Capital accumulation and growth

Column 12 of table 3 shows that prior to the turning point, the formal sector real wage is equal to the average product in the informal sector. The rate of formal sector profit is then computed in column 13 and column 14 shows the virtual rate of profit in the informal sector, if Q_2 were produced formally. Formal sector profit is shown in column 14 and investment as the savings rate times the *mass* of profits is shown in column 15. The last two columns show the GDP and the share of labor in the formal sector as the economy approaches the turning point.

As the economy reaches the transition point, the surplus labor in the informal sector steadily approaches zero. All informal activity thereafter is juridical as functional informality disappears. All production is formally produced with the real wage equal to the marginal product.

Table 3. The decline of functional informality as formal capital accumulates

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
	Surplus	Labor	Capital		Output		Fml/ Infml	Labor		Fml Share of	Avg Infml		Profit		Invest-	
Time	Labor	Supply	Fml[1]	Infml	Fml	Infml	Labor	Fml	Infml	Labor	Product	Wage	Fml	Infml	ment	GDP
0	2.9	120	230	60	100	50	1.40	70.0	47.1	0.58	1	1	0.13	0.05	16.5	150.0
1	2.8	120	233	60	101	50	1.41	70.2	47.1	0.58	1	1	0.13	0.05	16.7	150.7
2	2.6	120	237	60	101	50	1.42	70.4	47.1	0.59	1.01	1.01	0.13	0.04	16.7	151.3
3	2.4	120	241	60	102	50	1.43	70.6	47.1	0.59	1.01	1.01	0.13	0.04	16.7	152.0
4	2.2	120	244	60	103	50	1.44	70.7	47.1	0.59	1.02	1.02	0.13	0.04	16.7	152.6
5	2.0	120	248	60	103	50	1.44	70.9	47.1	0.59	1.02	1.02	0.13	0.03	16.7	153.2
6	1.9	120	251	60	104	50	1.45	71.1	47.1	0.59	1.02	1.02	0.13	0.03	16.7	153.8
7	1.7	120	254	60	104	50	1.46	71.2	47.1	0.59	1.03	1.03	0.12	0.03	16.7	154.3
8	1.6	120	257	60	105	50	1.47	71.4	47.1	0.59	1.03	1.03	0.12	0.03	16.7	154.9
9	1.4	120	260	60	105	50	1.48	71.5	47.1	0.60	1.03	1.03	0.12	0.02	16.7	155.4
10	1.3	120	263	60	106	50	1.48	71.7	47.1	0.60	1.03	1.03	0.12	0.02	16.7	155.9
11	1.2	120	266	60	106	50	1.49	71.8	47.1	0.60	1.04	1.04	0.12	0.02	16.7	156.4
12	1.0	120	269	60	107	50	1.50	71.9	47.1	0.60	1.04	1.04	0.12	0.02	16.7	156.8
13	0.9	120	272	60	107	50	1.50	72.0	47.1	0.60	1.04	1.04	0.12	0.02	16.7	157.3
14	0.8	120	274	60	108	50	1.51	72.2	47.1	0.60	1.05	1.05	0.12	0.01	16.7	157.7
15	0.7	120	277	60	108	50	1.51	72.3	47.1	0.60	1.05	1.05	0.12	0.01	16.7	158.2
16	0.6	120	280	60	109	50	1.52	72.4	47.1	0.60	1.05	1.05	0.12	0.01	16.7	158.6
17	0.5	120	282	60	109	50	1.53	72.5	47.1	0.60	1.05	1.05	0.12	0.01	16.7	159.0
18	0.4	120	284	60	109	50	1.53	72.6	47.1	0.60	1.05	1.05	0.12	0.01	16.7	159.3
19	0.3	120	287	60	110	50	1.54	72.7	47.1	0.61	1.06	1.06	0.12	0	16.7	159.7
20	0.2	120	289	60	110	50	1.54	72.8	47.1	0.61	1.06	1.06	0.12	0	16.7	160.1
21	0.1	120	291	60	110	50	1.55	72.9	47.1	0.61	1.06	1.06	0.11	0	16.7	160.4
22	0.0	120	304	63	138	28	3.46	98.6	21.4	0.78	1.04	0.98	0.14	0.12	25.3	166.3
23	0.0	120	331	68	142	28	-	98.9	21.1	1	0	1.01	0.14	0.11	27.0	170.4
24	0.0	120	359	74	146	29	-	99.2	20.8	1	0	1.03	0.13	0.10	27.6	174.5
25	0.0	120	387	80	150	29	-	99.4	20.6	1	0	1.05	0.12	0.10	28.1	178.4
26	0.0	120	414	85	153	29	-	99.7	20.3	1	0	1.07	0.12	0.09	28.4	181.9
27	0.0	120	441	91	156	29	-	99.9	20.1	1	0	1.09	0.11	0.09	28.8	185.3
28	0.0	120	467	96	159	30	-	100.0	20.0	1	0	1.11	0.11	0.08	29.1	188.4
29	0.0	120	492	101	161	30	-	100.2	19.8	1	0	1.13	0.10	0.08	29.4	191.2
30	0.0	120	516	106	164	30	-	100.4	19.6	1	0	1.14	0.10	0.07	29.7	193.9

[a] Fml = formal sector. Infml = informal sector.

Source: Authors' computations based on illustrative data.

Average growth in output is slow before the turning point, only one-half percentage point per period. Thereafter, growth accelerates to almost two percent. Part of the reason is the large jump in investment that takes place at the phase transition, when the second sector becomes formal. Part of the reason is the *decline* in the wage rate, dropping by more than 6 percent as the surplus labor is formally absorbed.

Why does this happen? In table 3 the phase transition is shown by the shaded line in period 22. The change in the state of the system begins with a *collapse* in the level of Q_2 as the employment, L_2, falls to a level consistent with the marginal productivity of labor. The cause of the transition is this change from functionally informal to formal status. The drop in the wage rate encourages the formal sector to employ much more labor, rising from 72.9 in period 21, to 98.6 in period 22. The wage reduction sets the stage for an acceleration in the rate of formal employment.

Figures 3 and 4 show that if the wage rate falls, formal sector processes will be able to absorb more labor and in the limit, the entire labor force. This could have happened at any point in the time path of the economy, but the assumption is that if the wage rate does indeed fall to a level supporting full employment, the wage would hit some minimum biological level. However, now that capital has accumulated, a market clearing wage could be feasible. The simulations shows that at the transition, the formal wage is *lower* that it had been with functional informality. To answer the "why does this happen" question of the previous paragraph, one must dig a bit deeper.

The first observation, made by (Blattman and Dercon, 2016), is that "it doesn't always happen." In a widely disseminated paper, the authors report on a 5-year experiment that addresses precisely this question. It appears that in Ethiopia, at least, the lure of formal sector employment is not dispositive. Of the workers offered formal sector jobs in the context of a randomized controlled trial, some two-thirds quit after one year, seemingly preferring the more "entrepreneurial" alternative offered by informal sector activity. The paper does not, lamentably, distinguish functional and juridical informality, but nonetheless casts a somewhat dark shadow on the simulations in table 3.

Conventional wisdom has robustly held that workers prefer formal to informal work, because of benefits, learning by doing, stability and potential wage growth, all features that are markedly absent in functional informality. (Blattman and Dercon, 2016), however, show that workers quit for valid reasons: many of them get sick or are hurt on the job. Informal work offers a flexibility of working hours that cannot be matched by factory work. In short, the latter is no picnic and this raises the crucial question of why workers in period 22 would give up their informal jobs for a *lower* formal wage.

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This would appear to refute the conventional wisdom, which has robustly held that workers prefer formal to informal work, because of benefits, learning by doing, stability and potential wage growth, all features that are markedly absent in functional informality. The conditions of work in the formal sector in the Ethiopian study, however, increasingly mimic those of the usual definition of informality. Other studies have found the same blurring of boundaries between formal and informal work (Bromley and Wilson, 2018), with similar deterioration in the relative formal wage, longevity of employment and health and safety conditions. While the movement between formal and informal may continue to reflect this decreasing opportunity cost of informal work, as noted above, other studies have found that workers in formal employment would not give up those jobs for informal work when formal improves welfare (Powell and Zwolinski, 2012; Rand and Torm, 2012).

These may simply reflect the basic characteristic of informality that is generally agreed upon, namely low human capital. Formal sector jobs available to those with low skills and/or education typically are at the lower end of the wage scale. In line with Blattman and Dercon (2016), Losby et al. (2002) find that in some countries, a large proportion of formal workers earn wages similar to those of low-waged

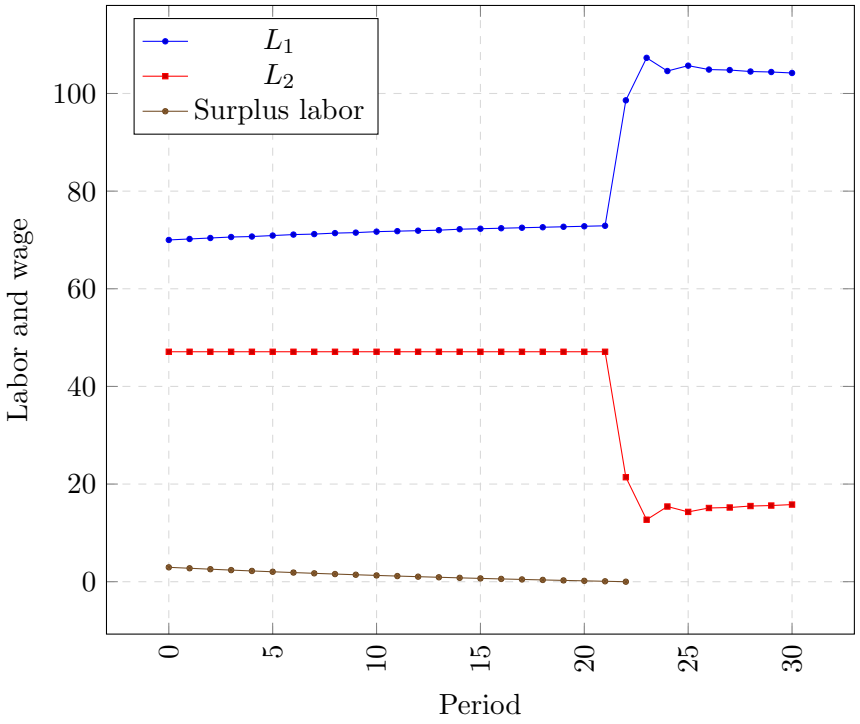

Figure 3. Employment before and after the functional/juridical turning point

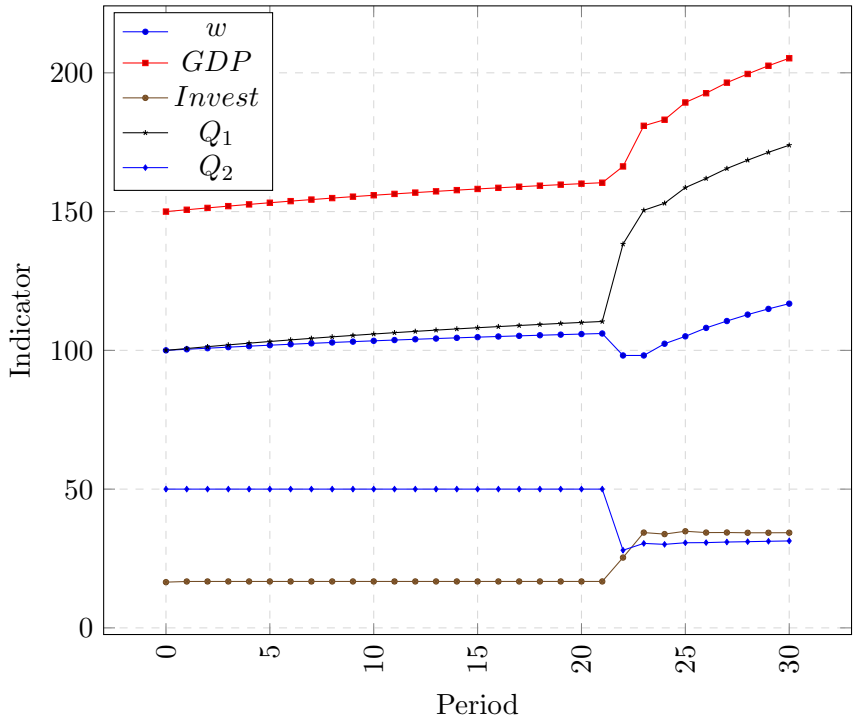

Figure 4. Macro indicators before and after the functional/juridical phase change

informal workers.

Certainly, to the extent that formal sector wages and working conditions mimic those in informal activities, any sharp distinction between the two sectors cannot be assumed. Nonetheless, to the extent that formal sector jobs provide the better wages and working conditions normally assumed, formality will continue to have benefits for the functionally informal because the opportunity cost of informality remains high. This would hold despite preferences for flexible working hours, independence or freedom from taxes leading some individuals to choose informality even where formal jobs are 'decent' work.

For the model developed in this paper, in any case, the definition of functional informality does not depend on directly on wages or working conditions. While a defective process can be associated with lower earnings and may involve worse working conditions, it is the capital constraint on operating a formal sector process that defines informality. The advantage of this definition is that it does not depend on the preferences of individuals, demographic characteristics or institutional context. Therefore, it can be applied consistently across countries and sectors that differ in these respects.

The narrative of this transition could unfold in the following way. Workers may hear of jobs newly available in the formal sector and be attracted to them. So long as there is no herding, there would only be an imperceptible drop in the wage rate as workers begin to trickle in. This subtlety is necessarily lost in the simulation, however, such that in the final days of the informal sector's existence, all informal workers simultaneously pool into the formal labor market. Naturally, the wage will take a steep decline. As discussed in detail below, the wage recovers, but informal sector workers with high discount rates could indeed forestall the turning point. Reality will certainly be clouded by these considerations and will be unlikely to follow the crisp path shown in the simulation of table 3.

Figure 4 shows that there has been a phase change, a qualitative change in the structure of the economy at the turning point. Beginning with the uppermost series, GDP, there is an observable jump as the functional informal sector fades. As noted, GDP grows, prior to the turning point, at only about 0.5 percent per period, while after the turning point (from period 23-30), GDP grows at slightly less than 2 percent. The real wage growth behaves in a similar fashion. Prior to the turning point, the growth rate is 0.3 percent. Despite the sharp drop at the phase change, the growth rate of labor increases dramatically to 2 percent and by the 4th period after the transition, wages exceed the maximum achieved prior to the turning point. There is full employment in the formal sector, by definition, after the phase transition.

The strengthening of the economy in the post-transition periods shows the power of formality, but the question arises as to precisely why it occurs. The answer lies in the rate of capital accumulation in the two sectors. Prior to the transition, there is no net capital accumulation in the informal sector, by assumption. There are scant resources to fuel the accumulation until the turning point, when sector 2 becomes formal. The fall in the wage rate causes profit in sector 2 to rise dramatically and total profits jump from 21 percent of GDP to 29 percent of GDP (not shown), providing for a qualitative change in the growth path of the economy. The capital stock growth rate responds appropriately; after the transition it rises to nearly 7 percent for both sectors, having grown in the pre-transition period at less than one percent for the formal and zero for the informal sector.

Figure 5 further confirms that informals effectively invest in formality with an expectation of a brighter future. There, consumption per worker, defined as GDP less investment divided by the labor force (see table 3), rises slowly as surplus labor is absorbed. At the phase transition, consumption per capita falls, but then quickly recovers as workers' wages rise with increasing marginal productivity. GDP growth also rises dramatically after the turning point, as noted, primarily because investment growth rebounds. The latter falls to nearly zero right before the phase transition since wages are determined by the rapidly growing average product in the informal sector and as the economy nears the critical point, investment growth virtually comes to a halt. Just after the phase transition, investment growth rises abruptly and then slows back to a steady growth as the capital stock in both sectors expands at a common rate.

4.3. Growth in the labor force

The simulation in table 3 assumes that the growth in the labor force is zero. This is obviously unrealistic for developing countries and only facilitates the explanation of the model. There is a dramatic effect of raising the rate of growth of the labor force on the quantity of functional informality. Figure 6 plots functionally informal labor as a share the growing labor force. In the base year, functionally informal labor is approximately 41.6 percent of the total. With no growth in the labor force, the transition takes 21 periods and informality falls to 39.2 percent of the labor force before surplus labor disappears and the economy becomes entirely formal. If the labor force growth rate is increased to just one-half of one percent, the figure shows that it takes far longer, 100 periods, and functional informality persists until it is only 23.7 percent of the labor force.[15]

This implies that the wage fall is not nearly as abrupt when the economy becomes strictly formal.[16] With faster rates of labor force growth, Figure 6 shows steeper decline in the share of the informal sector. With more workers in the informal sector the wage rate is lower and informal labor can be absorbed into the formal sector more readily.

As capital accumulates, however, diminishing returns in the formal sector sets in and the rate at which informal labor is hired falls dramatically. With a 2 percent growth in the labor force, it takes 37 periods for surplus labor to fall to half the labor force but several hundred more periods before the transition point. The longer transition period allows more informal labor to be absorbed and so the transition to full formality is less abrupt.

The number of periods before the turning point increases rapidly with population growth, highlighting the real-world difficulty of entirely disposing with functional informality. It also suggests an answer to the question of why the functionally informal sector persists, even with relatively rapid trade driven growth.[17]

5. A CGE model with an informal sector

The next step is to generalize the model to include a demand side in a full CGE framework (Davies and Thurlow, 2010; Gibson, 2005). In what follows, the formal economy is still aggregated into one sector and the informal sector is broken out. There is still only one good, produced by the formal and informal sectors. It would not require much to have a multiplicity of formal sectors, but it would add little to the discussion to follow and complicate matters significantly.

Household incomes are determined by the factor-to-household income matrix that relates the functional to the size distribution of income. This means that the model records both "rich" and "poor" households but does not assert that all the poor work in the informal sector. Thus, there are no"informal households"; poor households, nonetheless, will be far more likely to work in the informal sector than their rich counterparts. If the latter are observed to participate in the informal sector, they are more likely be juridical rather than functionally informal. It is to the latter that the model is principally addressed.

Households are related to factor income in CGE models through an income distribution matrix that takes the form of

$$\phi(i,j) = \begin{bmatrix} \phi_{1,1} & \phi_{1,2} \\ \phi_{2,1} & \phi_{2,2} \end{bmatrix}$$

[15]Even a one tenth of one percent increase in the growth rate of the labor force forestalls the transition by 4 periods. Higher growth rates cause functional informality to rise above the base level before falling, even though as a percentage of the labor force, the functionally informal still falls.

[16]When the population growth at one-half of one percent, the market clearing wage only falls to 1.02 rather than 0.98 as shown in table 3.

[17]See the online technical appendix for a discussion of how the model behaves with both population and productivity growth in the informal sector increasing over time. There it is seen that a reverse flow from the formal to informal sector can occur, consistent with the observations of Blattman and Dercon (2016).

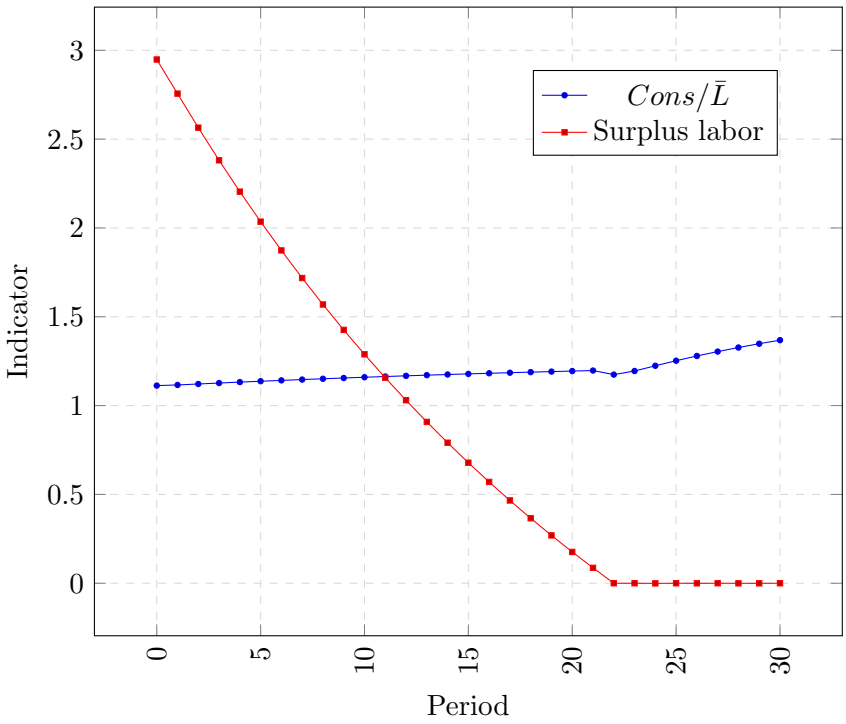

Figure 5. Consumption per worker and surplus labor

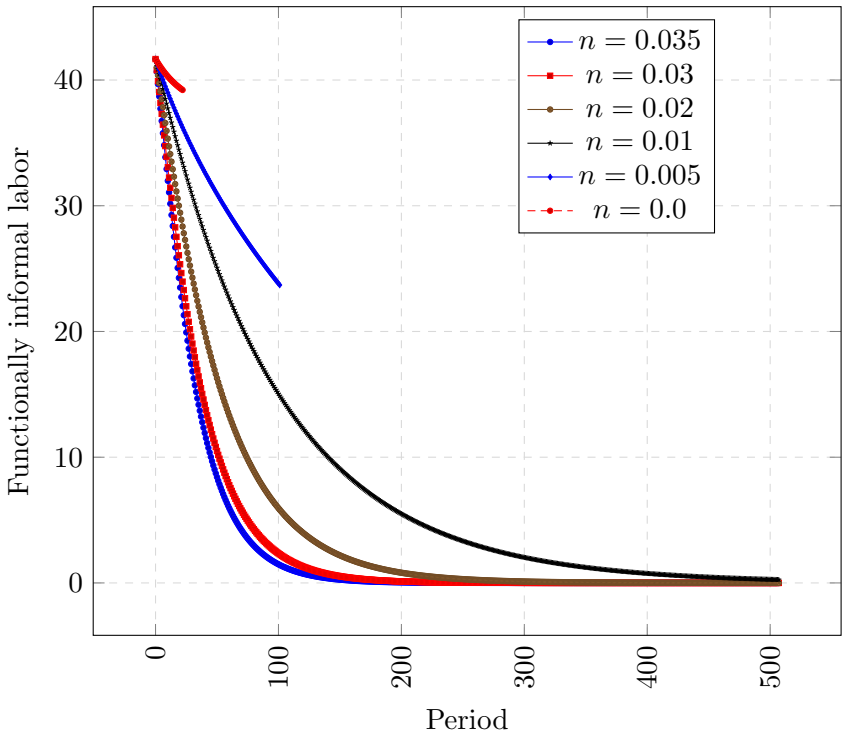

Figure 6. Functionally informal labor at various population growth rates. (Percent of the labor force)

where the i index is for factors, labor and capital, and the j is for households, poor and rich. Here, for example, $\phi_{2,1}$ is the amount of informal income received by the poor households and is likely to be large, while $\phi_{2,2}$ is the amount of informal income going to rich households and is likely to be correspondingly small.

Here, again, there are two production processes, one for the formal and one for the informal sector. All this, of course, assumes that the economy has not yet reached the turning point or phase transition, discussed above, at which there emerge two production processes, both formal, that hire factors in according with the conventional profit maximizing criteria.

The more realistic environment of the CGE model allows a slightly more elaborate account of the dynamics of formal/informal sector evolution. This was alluded to above, but now can be seen more clearly. The key difference is that the total amount of aggregate demand in the model determines the level of economic activity. Taking the level of Q_2 as endogenously determined (or, more realistically, by the growth of informal capital), Q_1 is now determined by the level of aggregate demand in the system.

How the level of informal output is determined depends on the structural characteristics of the economy. If the output is given, the suggestion is that the *marginal product of labor in the informal sector is effectively zero*. Labor can thus leave the informal sector without having any impact on the level of Q_2. Thus the real wage rises as the formal sector draws labor away from the informal sector. A second option is to assume that the labor coefficient, output per worker in the informal sector, is constant and as workers depart the informal sector, output falls in proportion. This is, in a sense, the opposite assumption; the marginal productivity of labor is not zero, but rather equal to the average productivity of labor in the informal sector.[18]

Rather than having formal sector demand for labor depend on the current level of the capital stock and the real wage rate determined in informal sector, the approach allows aggregate demand to determine the demand for labor in the formal sector. Again, there are two options. The first is to assume that demand for labor depends on the marginal productivity of labor as in equation 4, so that as the real informal wage rises, the demand for labor will contract. [19]

The formal sector is assumed to operate at less than full capacity, defined as the quantity it could produce if it hired labor up to the marginal product as determined by the full use of its capital stock. In a demand determined CGE model, however, it is not the quantity of the capital stock that limits production but rather the aggregate demand. For the formal sector, this is the amount of aggregate demand left unsatisfied by *informal* sector activity.

The question arises as to what is the level of Q in the marginal productivity equation 4 above. In the earlier model, it was determined by the capital stock and the real wage determined in the informal sector. To have a model of functional informality operating inside the CGE model, it is only necessary to introduce $Q_1' \leq Q_1$, where the prime indicates that the level of value added in the formal sector, as determined by aggregate demand, is *less* than what would be produced by the formal sector if the formal sector fully used its capital stock.

5.1. A simple example

Rather than jumping to a fully developed CGE model to illustrate how the informal sector can be incorporated, consider the simple example discussed in table 1. The table is reproduced below with intermediates added. For simplicity the distinction between rich and poor consumers has been suppressed. Like in standard Keynesian models, there is only one consumption function

$$C = \bar{C} + c(Q_1 + Q_2) \tag{8}$$

[18]The second case is elaborated in detail in the online technical appendix.

[19]A second approach, discussed in the online technical appendix, is to let the labor coefficient in the formal sector determine the quantity of labor hired there. In the first case, the level of the capital stock is important as well as aggregate demand. In the second case, it is only the level of aggregate demand that determines the growth in formal employment.

with a marginal propensity to consume of $c = 0.7$ and an intercept of $\bar{C} = 28.5$. The GDP is the same as in table 1 above, as is the distribution of value added by the formal and informal sectors. The labor force is again equal to $\bar{L} = 120$.

To see how demand modifies the basic structure of the model, consider the fact total aggregate demand, F, or GDP, Y, must be equal to total value added, Y

$$F = Y = Q_1' + Q_2 \tag{9}$$

where Q_i represents value added for both the formal and informal processes and where the price is taken to be unity for convenience. Here Q' has been substituted for Q in the formal sector to capture the idea that the value added in this sector no longer depends on the capital stock, but instead on aggregate demand.[20]

Equation 4 can then be expressed, after clearing the fractions, as

$$(1 - \beta_1)Q_1'(\bar{L} - L_1) = Q_2 L_1$$

substituting equation 9 into

$$(1 - \beta_1)(Y - Q_2)(\bar{L} - L_1) = Q_2 L_1$$

or solving for L_1

$$\frac{(1 - \beta_1)\bar{L}}{[(1 - \beta_1) + Q_2/(Y - Q_2)]} = L_1$$

where now it is clear that an increase in the level of demand, Y, will *increase* the demand for formal labor. Raising Q_2 reduces the level of demand for the formal labor, increasing functional informality, just as in the model above. Finally, an increase in $\bar{L}$ will cause an increase in the demand for formal labor, as the real wage in the informal sector falls. All this follows the pattern of the simple model in section 3.

The model is solved as shown in table 5. The table shows each variable and parameter of the simplified model. Parameters are determined either from the SAM or taken as given exogenously as shown in the table. In the case of the behavioural equations, the expression determining the value of the variable is shown along with its value in the first row of table 5.

The model is first calibrated to the SAM. The consumption function takes the marginal propensity to consume, c, as given and then computes the level of autonomous consumption consistent with the SAM value of total consumption, both formal and informal. Formal consumption is a residual after the informal consumption is deducted. Informal consumption is set to the gross value of production of the informal sector, less intermediate demand (which is small) for informal output. Informal investment is set to zero for simplicity, but in a more complete model, final demand for informal output would have to be distributed across the categories of final demand by some method not discussed here.

[20] Equation 9 may require some additional explanation. In table 5.1, the equation holds, but only in the aggregate. Specifically, one cannot write that $F_1 = Q_1$ and $F_2 = Q_2$. This is evident from the presence in off-diagonal terms in the I-O flow matrix. The material balance for the formal sector in the SAM is written

$$a_{11}X_1 + a_{12}X_2 + F_1 = a_{11}X_1 + a_{21}X_1 + Q_1.$$

While the first terms on both sides of this equation cancel, $F_1 = Q_1$ requires that $a_{21}X_1 = a_{12}X_2$, which does *not* generally hold.

Table 4. Informal SAM[a]

	Formal	Informal	Consum-ption	Invest-ment	Total
Formal	25.2	0.26	83.5	16.5	**125.8**
Informal	0.6	2.6	49.8	-	**52.9**
HH	100	50	-	-	**150**
Value added	-	-	-	-	-
Labor-Formal	70	37.5	-	-	**70**
Labor-Informal	-	50	-	-	**50**
Capital	30	12.5	-	-	**30**
Savings	-	-	16.5	-	**16.5**
Total	**125.8**	**52.9**	**150**	**16.5**	-

[a] Nominal LCUs. Infml = informal sector.

Source: Authors' computations.

Table 5. Solving the CGE model with an informal sector

Symbol	Concept	Source	Value	Equation
X_1	Fml GVP[a]	SAM	125.79	-
X_2	Infml GVP[a]	SAM	52.91	-
a_{11}	IO-coef	A_{11}/X_1	0.20	-
a_{12}	IO-coef	A_{12}/X_2	0.01	-
a_{21}	IO-coef	A_{21}/X_1	0.01	-
a_{22}	IO-coef	A_{22}/X_2	0.05	-
β_1	Fml capital share	SAM	0.30	-
β_2	Infml capital share	External	0.25	-
c	Marginal propensity	External	0.70	-
$\bar{C}$	Autonomous consumption	SAM	29	-
$\bar{L}$	Labor supply	SAM	120	2
L_1/L_2	Formal/informal labor	$(1-\beta_1)Q_1'/Q_2$	1.40	5
C_1	Fml consumption	$\bar{C}+c(Q_1+Q_2)-C_2$	83.87	8
C_2	Infml consumption	$Q_2-(a_{12}+a_{22})X_2$	49.64	-
I_1	Fml investment demand	SAM	16.50	-
I_2	Infml investment demand	SAM	0.00	-
L_1	Fml labor demand	$(1-\beta_1)Q_1/w$	50.00	4
L_2	Infml labor demand	$\bar{L}-L_1$	70.00	6
Q_1	Fml value added	$K_1^{\beta_1}L_1^{(1-\beta_1)}$	100.0	1
Q_1'	Fml value added[c]	$wL_1+(1-a_{11}-a_{21})X_1$	100.0	-
Q_2	Infml value added	SAM	50.0	-
K_1	Fml capital	External	230	-
K_2	Infml capital	External	60	-
w	Wage[d]	Q_2/L_2	1.00	3
L_s	Surplus labor	$\bar{L}-L_1-L_{2f}$	2.95	-
L_{2f}	Infml labor demand	$(Q_2/K_2^{\beta_2})^{(1/(1-\beta_2))e}$	47.1	6
δ	Depreciation	External	0.05	

[a] Gross value of production. [b]Fml = formal sector. [c] Determined by aggregate demand. [d] Average product in informal sector before turning point, while after turning point set to maintain zero surplus labor. [e] Notional.

Source: Authors' computations.

Table 6. The decline of functional informality with aggregate demand

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
						Fml/		Output								
	Surplus	GVP[a]				Infml	Fml	Fml	Infml		Labor		Capital		Labor	
Time	Labor	Fml[a]	Infml[b]	Cons	Invest	Labor	Q_1'	Q_1	Q_2	Wage	Fml	Infml	Fml	Infml	Infml[c]	GDP
0	2.95	126	52.9	133.5	16.5	1.40	100.0	100.1	50.0	1	70.0	50.0	230.0	60.0	47.1	150.0
1	2.79	126	52.9	133.9	16.7	1.41	100.6	101.5	50.0	1	70.2	49.8	235.0	60.0	47.1	150.6
2	2.63	127	52.9	134.3	16.8	1.42	101.1	102.8	50.0	1.01	70.3	49.7	239.9	60.0	47.1	151.1
3	2.47	128	52.9	134.7	17.0	1.42	101.7	104.1	50.0	1.01	70.5	49.5	244.8	60.0	47.1	151.7
4	2.30	129	52.9	135.1	17.2	1.43	102.2	105.3	50.0	1.01	70.6	49.4	249.5	60.0	47.1	152.2
5	2.14	129	52.9	135.5	17.3	1.44	102.8	106.5	50.0	1.02	70.8	49.2	254.2	60.0	47.1	152.8
6	1.98	130	52.9	135.9	17.5	1.45	103.4	107.6	50.0	1.02	71.0	49.0	258.8	60.0	47.1	153.4
7	1.82	131	52.9	136.3	17.7	1.46	104.0	108.6	50.0	1.02	71.1	48.9	263.4	60.0	47.1	154.0
8	1.65	132	52.9	136.7	17.9	1.46	104.6	109.6	50.0	1.03	71.3	48.7	267.9	60.0	47.1	154.6
9	1.49	132	52.9	137.1	18.0	1.47	105.2	110.6	50.0	1.03	71.5	48.5	272.4	60.0	47.1	155.2
10	1.32	133	52.9	137.5	18.2	1.48	105.8	111.5	50.0	1.03	71.6	48.4	276.8	60.0	47.1	155.8
11	1.16	134	52.9	138.0	18.4	1.49	106.4	112.4	50.0	1.04	71.8	48.2	281.2	60.0	47.1	156.4
12	0.99	135	52.9	138.4	18.6	1.50	107.0	113.2	50.0	1.04	72.0	48.0	285.6	60.0	47.1	157.0
13	0.83	135	52.9	138.8	18.8	1.51	107.6	114.0	50.0	1.04	72.1	47.9	289.9	60.0	47.1	157.6
14	0.66	136	52.9	139.3	19.0	1.52	108.2	114.7	50.0	1.05	72.3	47.7	294.2	60.0	47.1	158.2
15	0.49	137	52.9	139.7	19.2	1.52	108.9	115.4	50.0	1.05	72.5	47.5	298.4	60.0	47.1	158.9
16	0.32	138	52.9	140.1	19.3	1.53	109.5	116.1	50.0	1.06	72.6	47.4	302.7	60.0	47.1	159.5
17	0.16	139	52.9	140.6	19.5	1.54	110.1	116.8	50.0	1.06	72.8	47.2	306.9	60.0	47.1	160.1
18	0.0	165	31.2	141.0	19.7	3.11	131.2	152.5	29.5	0.95	96.7	23.3	311.1	60.0	23.3	160.7
19	0.0	165	31.3	141.0	19.7	-	131.1	153.0	29.6	0.95	96.6	23.4	312.0	60.2	23.4	160.7
20	0.0	165	31.4	141.0	19.7	-	131.0	155.0	29.7	0.95	96.6	23.4	316.2	60.4	23.5	160.7
21	0.0	165	31.5	141.0	19.7	-	131.0	157.0	29.8	0.95	96.5	23.5	320.1	60.5	23.5	160.7
22	0.0	165	31.6	141.0	19.7	-	130.9	158.8	29.8	0.95	96.5	23.5	323.8	60.6	23.5	160.7
23	0.0	165	31.6	141.0	19.7	-	130.9	160.5	29.9	0.95	96.4	23.6	327.3	60.7	23.6	160.7
24	0.0	165	31.6	141.0	19.7	-	130.8	162.2	29.9	0.95	96.4	23.6	330.7	60.7	23.6	160.7

[a] Gross value of production.[b] Fml = formal sector. Infml = informal sector.

[c] Labor demand if informal process operated formally.

Source: Authors' computations based on illustrative data.

Before the turning point, the process is defective in the sense that it hires more labor than would a modern, profit maximizing firm. The extra labor hired is given by

$$(Q_2/K_2^{\beta_2})^{[1/(1-\beta_2)]} > (1-\beta_2)Q_2/w$$

where $w = Q_2/(\bar{L} - L_1)$ and measures, as mentioned above, the defectiveness of a "defective process". Observe that as the wage increases the process is even more defective since the gap between L_2 required to produce Q_2 (the term on the left-hand side of the inequality) and the marginal productivity of labor, on the right, increases. This accounts for the abrupt change in labor demand at the phase transition discussed above.

Table 5.1 shows the results of the model simulated over time. Although the columns are not precisely identical to table 3, it is instructive nonetheless to compare the two simulations. Table 5.1 shows progress toward the turning point that is essentially driven by a growth rate in investment, set exogenously to 1 percent per period. This rather anaemic growth still beats the simple model of table 3 to the turning point by four periods (18 versus 22). This suggests that the two simulations are broadly comparable and it is seen that there is, again, a phase transition as surplus labor disappears. As the informal sector turns formal, the quantity of labor it can absorb falls dramatically. As a result, the wage must fall to enable the formal sector to increase its demand for labor. This follows the simulation in table 3 closely.

It is important to see that while the phase change involves some discontinuities, there is nothing unrealistic about the transition. The essence of the problem is that the informal sector becomes formal, with new operators of the production processes, that follow the standard first-order conditions for profit maximization. This causes the informal sector to discharge a great deal of labor in a relatively short amount of time.[21]

After the phase change, both formal and informal output are determined as in a standard CGE model, that is, by the factors of production as discussed above. The model solves for the wage rate that balances supply and demand for labor. As shown below, this causes the level of the wage to fall precipitously at the turning point (similar to the model in table 3). Thereafter, real wage growth follows capital accumulation and investment is determined by savings.

One of the important findings of the model building exercises is that the phase change that occurs when surplus labor is exhausted also involves a change in the "closure" of the model. When Q_1' rises to equal Q_1 it is no longer proper to say that aggregate demand determines the valued added. The aggregate demand equation 9 becomes essentially redundant since value added is determined by the available factors of production. The equation does not, however, go away; it must still be respected and the only way that this can happen is to make the level of investment an endogenous variable. This changes the nature of the model fundamentally, from one in which output and employment are demand driven to one in which the key macroeconomic variables are supply driven, driven by the supplies of the factors of production. Thus, after the phase transition, the formal/informal model behaves as any other computable general equilibrium system with a so-called "neoclassical" closure.[22] This claim does not mean that the model must remain at full employment of the factors of productions thereafter. Sluggish adjustment of factor prices could easily lead to unemployment of labor or capital and then the aggregate demand equation 9 would reassert itself to determine the levels of output and employment, as well as the other variables of macroeconomic interest.

Figure 7 shows three different levels of the growth in investment spending in the model of table 5.1 and the associated level of informal labor. Observe that a one percent rate of growth takes almost 4 decades to eliminate the informal sector. The rate of growth of GDP is anaemic, only 0.4 percent. In the second case, with investment growth of 2 percent, the time horizon is cut in half (GDP growth of 0.8 percent). Finally, a more rapid rate of growth of investment at 3 percent (GDP growth of 1.2 percent) causes the informal sector to lapse after approximately 13

[21] While no post-phase change SAM is presented, there would be no assumption, for example, that the pattern of intermediate use shown in table 5.1 would remain in force for the informal sector. In short, the disappearance of the informal sector changes *everything*.

[22] This all runs parallel to the model discussed above in section 3.

years.

6. From functional to juridical informality

The model of functional informality is based on the premise that workers prefer formal to informal work–independent of the wage rate–but this is not sacrosanct. In the functional model the central dynamic is the flow of labor from the informal to the formal sector, driven by a gravitational force that is impossible to resist. There can never be excess demand for formal labor so long as the reserve army of informals is available. In particular, without some growth in the labor force, there can never be an increase in *both* formal and informal labor simultaneously.

A rise in demand causes the risk-rate-of-return trade off to favor participation in the juridically informal sector. This implies that the worker must either leave the functionally informal sector or abandon her formal sector employment. In this case, the measured informality, both functional and juridical, does not appear to have changed in the eyes of government statisticians. Yet functional informality has declined.

However, a rise in investment or government spending is likely to *increase* juridical informality rather than decrease it. This gives an empirical foundation for the determination of the nature of informality. The policy response to this kind of informality is entirely distinct from that of the functional sort, requiring the closing of tax and regulatory loopholes and tighter implementation of labor standards. In a word, juridical informality requires juridical, that is, legal solutions.

7. Conclusions

The analysis here addresses issues concerning the mechanisms of adjustment, the type of informality, either "functional" or "juridical", and possible policy implications of the application of CGEs to informality. To dissipate functional informality requires sufficient investment in both physical and human capital to enable all those willing to work at the equilibrium wage a job in the formal sector. Policy makers can go astray in conflating suppression of the functionally informal with effective economic development. These are not the same things and outright suppression of the functionally informal in fact can slow down the transition to full formality in the economy. Therefore, any effective policies for development are fully consistent with the theoretical framework advanced in this paper, including industrial policy, improved access to credit, income redistribution, or more broadly, any structural transformation that enhances growth.

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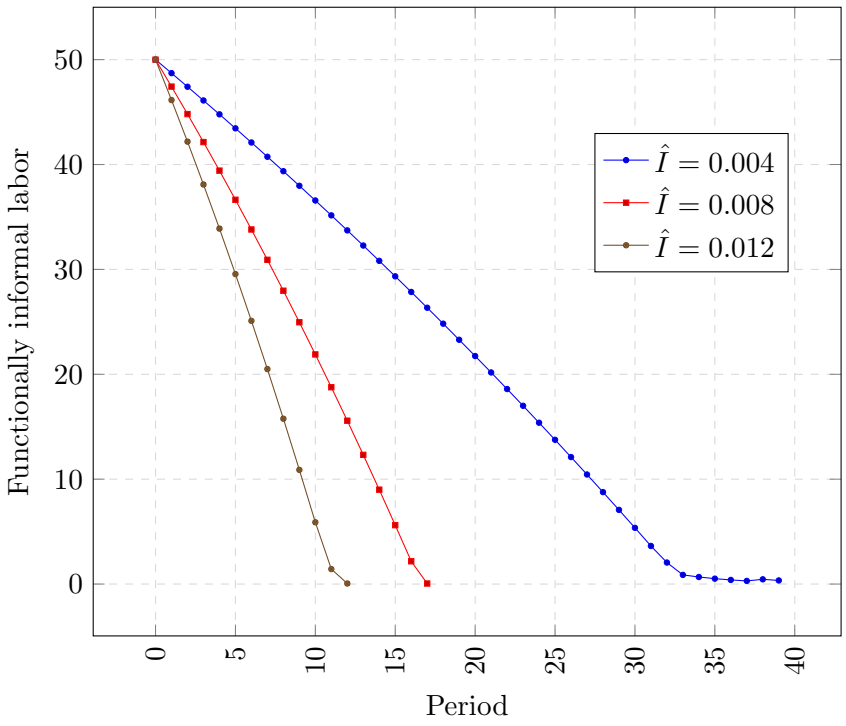

Figure 7. Functional informal labor at various growth rates of aggregate demand