Informality, Consumption Taxes and Redistribution

Pierre Bachas, Lucie Gadenne & Anders Jensen*

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Abstract

What is the redistributive capacity of taxes on consumption in developing countries? We combine household expenditure data from 32 countries with theory to establish the optimal design of consumption taxes and their impact on income inequality. We use the type of store in which purchases occur to proxy for informal (untaxed) consumption. In all countries, the budget share spent in informal stores steeply declines with income. This makes consumption taxes strongly progressive as the effective tax rate rises with income. We derive optimal tax policies by extending the canonical commodity tax model to allow for informal consumption and calibrate it to our data. Contrary to consensus, our results show that consumption taxes are redistributive and reduce inequality. Moreover, once informality is considered, the widespread policy of rate differentiation across goods has limited redistributive impact. In particular, reduced rates on necessities cannot be justified on equity grounds in the poorest countries. JEL: E26, H21, H23, 023
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*Pierre Bachas: World Bank Research, pbachas@worldbank.org. Lucie Gadenne: University of Warwick, Institute for Fiscal Studies and CEPR, l.gadenne@warwick.ac.uk. Anders Jensen: Harvard Kennedy School and NBER, Anders_Jensen@hks.harvard.edu. We would like to thank Michael Best, Anne Brockmeyer, Roberto Fatal, Rema Hanna, Gordon Hanson, Xavier Jaravel, Michael Keen, Joana Naritomi, Henrik Kleven, Wojciech Kopczuk, Joel Slemrod, Johannes Spinnewijn, Mazhar Waseem and numerous seminar participants for helpful comments. We thank Eva Davoine, Elie Gerschel, Mariana Racimo, Roxanne Rahnama and Alvaro Zuniga for excellent research assistance. We gratefully acknowledge financial support from the Weatherhead Center for International Affairs at Harvard University, the World Bank Development Economics' Research Support Budget, and UKAID through the IFS's TaxDev Centre. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not represent the views of the World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent. Replication codes for the paper are available here.

1 Introduction

Income inequality in developing countries is higher than in most rich countries and has persisted over the past 30 years (Alvaredo and Gasparini, 2015). What is the redistributive capacity of taxes on consumption? This is an important question in developing countries where consumption taxes represent the main source of government revenue and where direct income taxes are constrained in scope (Jensen, 2019). We combine a new micro database, covering countries at different income levels, with theory to systematically investigate consumption taxes' redistributive capacity. Our analysis yields two main findings. First, due to differences in informal (untaxed) consumption along the income distribution, consumption taxes are progressive and reduce inequality. Second, the redistributive impact of rate differentiation across goods, a widespread policy in practice, is weakened when accounting for informal consumption patterns within goods; in particular, tax exempting necessities (such as food) cannot be justified on equity grounds in low-income countries. Our results run counter to the consensus view that taxes on consumption have negative or neutral distributional impacts.

Our starting point is the construction of a new micro database of expenditure surveys from 32 low and middle income countries. Surveys are included only if they reference the store type for each purchase. Our focus on store types is motivated by the vast disparities in consumption by place of purchase across countries: Figure 1a-1b shows that economic development is associated with a rise in consumption in modern stores (supermarkets, specialized stores), which gradually replaces consumption in traditional stores (home-based, street stalls, corner stores). Importantly, modern and traditional stores differ in structural characteristics which determine tax enforceability, including size, organizational structure and interaction with third-parties. Our main formality assignment assumes that purchases from modern stores are formal, in the sense that consumption taxes are remitted on these sales, while traditional stores are informal. We provide quasi-experimental evidence from one country and descriptive evidence across countries which suggest that this assignment is reasonable to a first order.

We use this database to establish new stylized facts on consumption patterns across the household income distribution and over development. We document the existence of a downward sloping Informality Engel Curve (IEC): the infor-

mal (i.e. traditional store) budget share steeply declines with household income in every country. Studying underlying factors, we find that access plays a limited role in accounting for the IEC; rather, non-homothetic preferences for quality and goods contribute to the differences in informal consumption between poor and rich households. Our data also allows us to study patterns of informal consumption within goods. We focus on food versus non-food goods since a tax rate reduction on food is the most common equity motivated policy. Accounting for informal consumption fundamentally alters the goods level patterns: while the overall budget share of food decreases as countries get richer, the formal food budget share *increases*; while the overall food Engel curve is steep and negative in all countries, the formal food Engel curve has a small but *positive* slope in low-income countries, and only becomes negative in upper-middle income countries.

These patterns determine the progressivity of consumption taxes. A tax is progressive if the effective tax rate (ratio of taxes paid to household income) increases with household income. In the average developing country, we find that a uniform consumption tax rate (levied on all formal consumption) is strongly progressive, due to the downward-sloping IECs: the effective tax rate of the richest quintile of households is twice that of the poorest quintile. Moreover, the progressivity gain from rate differentiation (exempting food while still taxing non-food) is limited, since poor households' food consumption mostly occurs in informal stores. To observe the implications of omitting informality for tax policy assessment, we contrast these results to an unrealistic scenario where all consumption is tax enforceable: the progressivity of rate differentiation is overestimated by a factor of 2.5 when informal consumption is not taken into account.

The progressivity of consumption tax policies varies with development. Progressivity achieved with a uniform rate is highest in low-income countries and decreases with development. This is because the aggregate informal budget share is large in low-income countries, which, combined with a negative IEC slope, implies that a formal purchase is a strong tag for high income households (Akerlof, 1978). As the informal budget share shrinks with development, formal purchases become a weaker income tag. On the contrary, rate differentiation produces no progressivity gains in the poorest countries, but leads to moderate gains in upper-middle income countries. Due to stark differences between formal food and informal food consumption patterns, it is also in the lowest-income coun-

tries that failing to account for informality leads to the largest overestimation of progressivity gains from rate differentiation.

What are the implications of these consumption patterns for tax design? We extend Diamond (1975)'s multi-person model of optimal commodity taxes in two directions: we introduce formal and informal varieties of each good; and, we allow for changes in consumption patterns over development. Introducing informal varieties, which cannot be taxed, increases the efficiency cost of taxes since households substitute consumption towards them when the tax rate increases. The efficiency cost decreases over development as the informal retail sector shrinks. Calibrating the model to our data, and using substitution elasticities from the literature, we find that the optimal uniform tax rate slightly increases with development, as the reduction in efficiency cost (which increases the rate) dominates the reduced progressivity (which decreases the rate). Moreover, the optimal level of rate differentiation between food and non-food also increases with development; in low-income countries, reduced rates are hard to justify on equity grounds.

To measure the impact of consumption taxes on inequality, we combine the calibrated optimal rates with our microdata. We find that the optimal uniform tax rate reduces the Gini coefficient by 1% in the lowest-income countries and by up to 3% in upper middle-income countries; with rate differentiation, the inequality reduction ranges from 1.1% to 3.9%. This inequality reduction is comparable in magnitude to that achieved by *actual* personal income taxes (PIT) in developing countries (2.6%, based on Lustig, 2018). Inequality reduction achieved with an optimal PIT would likely be larger: indeed, Atkinson and Stiglitz (1976) shows theoretically that redistribution is better achieved through direct rather than indirect taxes. However, this theoretical result assumes that income taxes are perfectly enforceable, which is at odds with developing countries' environment (Jensen, 2019). In an extension, we show that incorporating a realistically enforceable PIT lowers the inequality reduction achieved through consumption taxes by 10%.

Our results are derived under the assumption that consumption taxes are levied on all purchases (none) in modern (traditional) stores. We conduct several exercises to gauge the plausibility of this assumption. First, we combine datasets across countries which contain information on modern and traditional retailers: we estimate that 10% of traditional stores are formal, while 85% of modern stores are formal. Moreover, the formal shares within both store types are fairly constant

across low and middle income countries. This is consistent with a setting where the growth of modern retailing drives the increased enforceability of consumption taxes over development, rather than changes in enforceability within store types. Second, informal stores' consumers may still bear a tax burden if these stores purchase some inputs from formal suppliers. We provide quasi-experimental evidence from Mexico, a country in our sample, that the pass-through of a VAT rate increase to informal retailers' prices is limited. We show our results are robust to alternative formality assignments based on the cross-country or Mexican results.[1]

Our paper provides two main contributions. First, combining new data with theory, we show that consumption taxes are progressive and reduce inequality in developing countries.[2] This finding runs counter to the consensus policy and academic view, which argues that indirect taxes have limited redistributive potential (Sah, 1983; Gemmell and Morrissey, 2005). Previous studies do not account for informal consumption, which, as we show, improves redistribution.[3] A major constraint in studying informality is that, by definition, it is hard to observe informal purchases and even harder to link them to consumers' incomes. We innovate by using the types of stores in which households report purchasing items to proxy for informal consumption. This consumption based measure of informality complements existing approaches which focus on informality at the firm and/or worker level.[4] Our findings caution that while enforcement policies to reduce informality may yield efficiency gains, they have distributional costs.

Second, we establish the redistributive potential from rate differentiation across goods, which speaks to the literature on consumption tax design under limited enforcement capacity (Pomeranz, 2015; Naritomi, 2019; Waseem, 2020).[5] Rate differentiation is a widespread policy, implemented in 90% of developing countries, but evidence of its effectiveness is scant.[6] We combine theory and data to under-

[1] Section 7 discusses more complex incidence settings (Benzarti and Carloni, 2019).

[2] Recent studies find societal benefits from increased tax revenue and improved tax capacity (Casaburi and Troiano, 2015; Weigel, 2019; De Simone, 2020). The literature on tax capacity and inequality is more limited (Alstaedseter et al., 2018; Londono-Velez and Avila-Mahecha, 2021).

[3] Our approach is related to recent papers on the impact of consumption patterns across the income distribution in rich countries (Faber and Fally, 2017; Jaravel, 2019; Allcott et al., 2019)

[4] Including La Porta and Shleifer (2014); Gerard and Gonzaga (2016); Ulyssea (2018).

[5] More generally, we contribute to the literature on optimal tax design with imperfect enforcement, which focuses on the efficiency cost of taxes (Boadway and Sato, 2009, Best et al., 2015); we consider both equity and efficiency impacts of informal consumption.

[6] See Sah (1983) for the UK and Ahmad and Stern (1984) for India.

take the first systematic analysis of optimal rate differentiation across goods and its impact on inequality in a large sample of developing countries.[7] Our results show that optimal rate differentiation depends on the extent to which consumption in informal stores alters the shape of goods' Engel curves. As such, our paper speaks to the large body of work which estimates Engel curves across countries, but which does not account for store types (Deaton and Paxson, 1998; Anker et al., 2011; Almås, 2012). Recent studies have documented aggregate changes in consumption by store types over development (Bronnenberg and Ellickson, 2015; Lagakos, 2016; Atkin et al., 2018b); by compiling a new micro database, we document the association between household income and store types within and across countries, and relate these patterns to tax policy design and redistribution.

2 Data

In this section, we describe the data sources and selection criteria used to construct our micro dataset. Next, we outline how we measure consumption by store type. Finally, we describe secondary datasets.

2.1 Data Sources and Selection Criteria

We assemble our main dataset by combining household expenditure surveys from countries that satisfy three selection criteria. First, the survey must be nationally representative. Second, the survey must record consumption from open diaries rather than pre-filled diaries, which only contain information on selected goods. This helps to ensure that the survey covers all expenditure types. Third, the diary must ask households to report the store type where each item is purchased - the *place of purchase* - and this information must be systematically reported in the diaries. This last criterion ensures that we can apply our method to robustly measure consumption by store type, as described below.

Using these criteria, we includes surveys from 32 countries covering approximately 400,000 households. Table 1 lists alphabetically the countries in the data, with their survey name and year, the number of households, and the average number of purchases reported per household. Countries in the sample are prin-

[7] Our main results focus on food versus non-food rate differentiation, but we also show results for optimal differentiation between 12 large goods categories.

cipally located in Latin America and Sub-Saharan Africa. Unfortunately, most household expenditure surveys in Asia do not contain information on the place of purchase. Nonetheless, our dataset covers a wide range of income levels, from Burundi to Chile. Appendix B provides further details on the data sources used.

2.2 Measuring Consumption by Store Type

Our objective is to measure consumption by place of purchase in a way that can be compared between households both within and across countries. A measurement challenge is that the 32 surveys in our database do not share the same design. We create a taxonomy of place of purchases which aims to achieve international comparability, drawing on the framework established by the International Price Comparison Program. Our taxonomy contains seven categories for place of purchase. The first five pertain to purchases of goods: (1) non-market consumption (e.g. home production); (2) non brick and mortar stores (e.g. street stalls, public markets); (3) corner and convenience stores; (4) specialized stores (e.g. clothing stores); and, (5) large stores (e.g. supermarkets, department stores). Purchases of services can be allocated to two main categories: (6) services provided by an institution (e.g. banks, hospitals); and, (7) services provided by an individual (e.g. domestic services).[8] These categories account for 86% of total household expenditure. The remaining 14% are items for which no place of purchase is specified, primarily utilities, fuel and telecommunication (see Figure A1).

We use an aggregated store classification for our main analysis, assigning categories (1) through (3) to the *traditional store type*, and categories (4) and (5) to the *modern store type*.[9] We do this for two reasons. First, the modern-traditional classification is commonly used in academic studies (Reardon et al., 2003; Humphrey, 2007; Lagakos, 2016) and market research on global retail patterns. It is based on the logic that differences in retailing across space and time are captured meaningfully by focusing on these two retail groups, since stores within each group share similar characteristics in most settings, but stores across group are systematically different in terms of sales, market orientation, and organizational structure. Our modern-traditional classification mirrors that of existing studies. Second, as

[8]The list of original store types in all surveys, and our classification, is shown in the online appendix. We exclude housing expenditure due to limited data on owner-occupied imputed rents.

[9]We cover the assignment of services after discussing the tax status by store type in Section 3.

discussed in Section 3, these store types differ significantly in tax enforceability characteristics and compliance status.

Finally, we classify goods according to the UN's COICOP methodology. This allows us to observe how purchases in modern and traditional stores differ within increasingly narrow product categories; we focus on food vs non-food, as well as the 12/47/117 goods categories of the COICOP 2-digit/3-digit/4-digit level.

2.3 Additional Data

Euromonitor market research We use data from the country specific retail reports produced by the private market research firm Euromonitor International. These reports contain information on modern and traditional retail food stores for each country (N=189), including number of outlets and total sales. The modern and traditional categories are consistent with our classification, with the exception that Euromonitor does not measure home-based consumption. The data reported is based on direct collection from retailers, surveys of retail trade, desk research and public data sources (see Appendix C.1 and Bronnenberg and Ellickson, 2015).

Mexican retail census and prices We use two datasets from Mexico. First, the 2013 Census collects information on the universe of retailers, including taxes levied on sales and paid on inputs. It contains a store classification that is consistent with our categorization, with the caveat that home-based consumption is not included. Second, we use the confidential monthly price quotes collected by the national statistics office. This dataset contains prices sampled for all items, store types, and locations representative of Mexican consumption. We merge this dataset with the census using unique store identifiers. This allows us to measure prices in both formal and informal retail stores (details in Appendix C.3).

3 Measurement of Informal Consumption

In this section, we describe the characteristics of modern and traditional retailers which determine tax enforceability. Next, we introduce our assignment of tax formality status by store type, and then support it empirically.

3.1 Characteristics of Modern and Traditional Retailers over Development

Modern and traditional stores differ in characteristics which are key determinants of tax enforceability. Figures 1c-1d show that, in most developing countries, the average modern store is approximately 40 times larger in sales than the average traditional store. This difference translates into enforcement intensity since tax administrations devote more resources to monitor larger firms (Basri et al., 2019; Bachas et al., 2019). In addition, modern stores occupy 20 times more floor space than traditional stores (Figures 1e-1f). The larger space allows modern stores to accommodate more customers, employ more personnel, and hold more inventory. Studies in global retailing identify the adoption of advanced accounting records as a key driver of modern stores' expansion: it allows precise tracking of inventory, recording of activities, and integration with suppliers (Evenson, 2007). The public finance literature convincingly shows that the existence of information trails, through accounting records and reports by third-parties including customers, employees and suppliers, are key determinants of tax enforcement success (Kleven, 2014; Pomeranz, 2015; Naritomi, 2019). The size and expanded coverage of third-party information implies that modern stores are much more likely to be tax compliant than traditional stores.[10]

3.2 Assignment of Formality by Store Type

Baseline assignment Our definition of formality is based on whether it is likely that consumption taxes are levied and remitted on purchases in a particular store type. Motivated by the previous subsection, our baseline assignment considers that all purchases made in traditional stores are informal (categories 1 to 3) and all purchases from modern stores are formal (categories 4 and 5). For services, we assume that institutions are formal while individual providers are not, leading us to assign category (6) to formal and (7) to informal.[11] This assignment is transparent, and we can directly gauge its plausibility in Mexico. The Mexican retail Census collects information on VAT remittance for all firms, and allows us

[10] This is consistent with macro studies of retailing that assume traditional (modern) stores are evading (compliant), including Lagakos (2016).

[11] Following the same logic, we assign expenditures in the unspecified category to formal retail: these expenditures are mainly utilities provided by large institutions which cannot evade taxes (Figure A1). In the online appendix., we show for each country the original names of the places of purchase, their expenditure shares and our formality assignment.

to classify retailers into modern and traditional stores. Only 9.5% of traditional stores report remitting VAT, whereas most modern stores do (Figure C1).

Cross-country evidence To our knowledge, censuses in other countries do not contain information on both tax status and store types. To measure tax formality status by store types across countries, we instead rely on the World Bank (WB) Enterprise and Informal Surveys and the Euromonitor retail reports. The WB surveys measure formality status (tax registration) by sales, but not store type, in 35 developing countries. The retail reports allow us to compute the average sales of modern and traditional retailers in the same countries. We measure the formality share in modern stores as the intersection between the WB survey based sales distribution of formality likelihood and the report based average sales of modern stores. We repeat this exercise to estimate the formal share of traditional stores.[12] The formal share in modern stores increases from approximately 80% in low income countries to 90% in middle income countries; the traditional stores' formal share is on average 10%, with little variation across countries (Figure C2). Despite data imitations, these patterns appear steady across countries and are consistent with the view that tax formality in traditional and modern stores is stable over development. In this setting, the increased enforceability of consumption taxes over development is primarily driven by the growth of modern retail's market share, rather than changes in enforceability within store types. In robustness checks, we will use this data-driven, country-specific assignment of formality probabilities to modern and traditional retailers in each country (details in Appendix C.1).[13]

VAT exemption thresholds The variation in formality by store type is driven in part by differences in enforceability. In addition, traditional stores can be legally informal, if their size falls below the VAT exemption threshold.[14] We code the

[12]Details in Appendix C.1, which also discusses measurement issues from combining these data. The WB surveys and the formality variable are the same as in La Porta and Shleifer (2014).

[13]While we focus on formality status at the modern vs traditional level, Figure A3 shows the budget shares by detailed store type. Home-production and street and market stalls account for over 75% of traditional consumption across the household income distribution. These are arguably the store types with less uncertainty about formality status (compared to corner stores).

[14]The enforceability of traditional stores and their location relative to the exemption threshold are related. Indeed, the VAT exemption threshold is typically set with enforcement constraints in mind, given that the tax revenue-yield can be small relative to the administrative and compliance costs. See Ebrill and Keen (2001); Keen and Mintz (2004) for a discussion of VAT thresholds.

value of the VAT threshold in all sample countries: the ratio of store average value to the exemption threshold is 1.01 for traditional stores and 38.85 for modern stores (Appendix C.1). This suggests that some traditional stores are informal (as defined here) because they are not legally required to levy VAT on their sales.[15]

3.3 Input VAT and Tax Pass-Through on Prices

Role of suppliers Even if traditional stores do not levy VAT on sales, they may still pass on part of a tax rate increase to their consumers if they purchase inputs from a VAT-formal supplier (Keen, 2008) or if they adjust their prices.[16] Appendix C.2 formalizes this intuition in a model, where formal and informal retailers engage in monopolistic competition and where informal retailers purchase some of their intermediate inputs from formal suppliers. The model predicts that the pass-through of a VAT rate increase to consumer prices in informal stores is equal to the share of inputs from formal suppliers in total input costs. How important are formal suppliers to informal retailers? Theory and evidence show that the VAT creates a cost of trading between tax and non-tax firms, leading to segmentation between formal and informal supply chains (De Paula and Scheinkman, 2010; Gadenne et al., 2019; Asatryan and Gomtsyan, 2020). While these results imply a reduced formal input share, there is no systematic study (or data) investigating this prediction for informal retailers in developing countries. However, we observe the input shares by tax status in the Mexican retail census: among informal retailers, the VAT-formal input share is 10% (details in Appendix C.3). Given the lack of systematic evidence, we apply the Mexican 10% pass-through rate to traditional retailers in all countries as a robustness check.

Evidence from a Mexican reform The Mexican setting allows us to directly estimate the pass-through among informal stores' prices and test the model prediction. In January 2014, the VAT increased from 11% to 16% in border areas to equal the non-border rate which remained at 16%. Our identification strategy compares price changes in informal retailers between border and non-border areas over time. The difference-in-differences design recovers the causal impact of

[15] Traditional retailers below the exemption threshold may still voluntarily register for VAT. However, Almunia et al. (2019) predict that optimal voluntary registration is more prevalent for manufacturing firms than retailers, due to their location at intermediate levels of supply chains.

[16] We confirm that a VAT is in place in all the 32 countries in our data.

the VAT increase on informal retail prices if there are no changes to unobservable factors which coincide with the timing of the reform and differentially impact prices in border versus non-border informal stores. The absence of pre-trends supports this assumption (Figure 2a). We implement a flexible regression model which includes all months dummies between January 2012 and December 2015 (reference period is the month of reform announcement, August 2013):

$$lnp_{glt} = \sum_{t=Jan2021}^{Dec2015} \beta_t(Border_l * Period_t) + \mu_g + \mu_l + \mu_t + \epsilon_{glt} \quad (1)$$

where lnp_{glt} is the log of the VAT-inclusive price of product g in location l at time t; μ_g, μ_l, and μ_t are fixed effects at the product, location and time level, respectively. $Border_l = 1$ if the location is in the border areas. Standard errors are clustered at the product-location level. We focus on the 127 products which constitute the core inflation items and which are subject to VAT. The estimation sample consists of 409,864 product-location-month price observations in informal stores (additional information in C.3). Figure 2b plots the coefficients from estimating (1) together with the 95% confidence intervals. For comparison, the figure also plots the 0.5% increase in prices, predicted by the appendix model in C.2, using the Mexican formal input share; and, the 5% increase in prices that would materialize under full pass-through to consumer prices. The figure reveals a small increase in border areas in the post-reform months, which averages 0.47%. While not statistically significant, this point-estimate of the pass-through in informal stores is close to the model prediction (0.5%) but far from full pass-through (5%). The results are unchanged if we instead estimate the pass-through to traditional stores, given the strong overlap of informality and traditional stores (C.1).

Taken together, these results suggest that although some traditional stores may remit VAT, through their own tax status or that of their suppliers, the quantitative importance of these channels appears limited. The baseline formality assignment, where modern retailers are formal and traditional retailers are informal, is transparent and appears reasonable to a first order. It constitutes our reference for the rest of the paper, but we show robustness to alternative assignments, allowing for country-specific formality probabilities in modern and traditional stores or pass-through of taxes to informal stores.

4 Engel Curves of Informality and Food across Development

In this section, we show how informal consumption varies with income within and between countries and then investigate the determinants of these differences in consumption. Next, we show how food and non food consumption differs in formal and informal stores and document how these patterns vary with income.

4.1 Informality Engel Curves

To study how informal consumption varies with income, we measure the informality Engel curve (IEC). The IEC traces the relationship between the informal budget share and total household expenditure within a country. We proxy income with total expenditure due to known issues with measuring income in developing countries (Deaton and Paxson, 1998; Atkin et al., 2018a). We use the logarithm of total household expenditure per person, in line with the literature measuring Engel curves (Deaton, 1997). For illustrative purposes, Figure 3 plots the IEC for a low-income country (Rwanda) and a middle-income country (Mexico). To investigate the functional form flexibly, the non-parametric IEC is constructed from local polynomial regressions. In Rwanda, the informal budget share falls from 90% for the poorest decile of households to 70% for the richest decile. In Mexico, the IEC is steeper, falling from 55% to 25%. We find two empirical regularities in the full sample.[17] First, IECs slope downward everywhere. Second, IECs are approximately linear in log expenditure. This suggests a stable functional form relation between informal budget shares and household expenditure.[18]

We summarize the information contained in the country-level IECs with two empirical moments: i) the aggregate informal budget share; ii) the slope of the IEC. In Section 5, we explain how these two moments are sufficient to characterize the relation between consumption patterns and tax progressivity. In Figure 4, we plot the aggregate informal budget share (Figure 4a) and the estimated IEC slope (Figure 4b) against countries' GDP per capita. Figure 4a reveals a large drop in the aggregate informal budget share, from over 90% in the poorest countries to 20% in upper-middle income countries. In Figure 4b, we observe that the negative

[17] Country level IECs are plotted for all 32 countries in the online appendix.

[18] Almås (2012) similarly finds a stable log linear relation between food budget shares and household income around the world. For more disaggregated goods, however, Engel curves can be non-linear and vary across countries (Atkin et al., 2018a).

IEC slope first increases in magnitude, between lower income to middle income countries, and then slightly decreases, between middle and upper-middle income countries. The average IEC slope is -10.2, implying a 1 percentage point reduction in informal budget share when household expenditure increases by 10%. Figure A4 shows that these patterns are similar when using the alternative assignment rules (country specific, input pass-through) detailed in Section 3.

4.2 Understanding Differences in Informal Consumption across Households

Our micro database allows us to quantitatively investigate some of the main hypotheses that qualitative studies on retailing put forward to explain differences in informal consumption between households. The first hypothesis is that poor and rich households differ in characteristics which impact consumption choices. To measure how much of the IEC can be explained, we estimate the following regression separately for each country:

$$Share\ Informal_i = \beta * ln(expenditure_i) + \Gamma X_i + \varepsilon_i \tag{2}$$

where i indexes a household, X_i are household characteristics. Table 2 shows the average of the slope coefficients β across countries. Column 1 displays results from the specification without controls, while column 2 controls for household demographics (household size, and age, education and gender of household head). These controls account for economies of scale across households of different sizes and life-cycle patterns which could affect where households shop (Deaton and Paxson (1998). We find that these characteristics do not explain the association.

The second hypothesis is that poor households' access to formal stores is limited (Lagakos, 2016). To test this, we include controls for household location in columns 3 and 4, either with an indicator for rural area or with survey block fixed effects.[19] We find that access matters, but only to a certain extent: controlling for rural location (block location) reduces the average slope by 16% (28%).[20]

The third hypothesis is non-homothetic preferences: richer households spend more on goods predominantly sold in formal stores. To test this, columns (5) to (8)

[19]The survey block is the most granular location information and contains on average 74 households in our surveys. The median survey block is representative on average of 52,900 households.

[20]The informal budget share is on average 72% in rural areas versus 60% in urban areas.

show product-level versions of (2) at increasingly granular product levels.[21] Preferences across goods play an important role: controlling for food versus non-food lowers the slopes by 42% (column 5), and controlling for the 12 goods categories at COICOP 2-digit level accounts for 50% of the variation (column 6). Controlling for narrower goods categories only slightly reduces the slope further.

Column 9 in Table 2 combines all three hypothesis, which collectively account for 54% of the variation. Nonetheless, even with these extensive observable controls, the average IEC slope is -4.6 and remains statistically significant in all but three countries. The fourth hypothesis is that, within location and product categories, richer households value higher quality varieties which are more likely to be sold in formal stores. Such taste-based preferences are unobservable in the context of equation (2). Instead, we leverage the fact that in six countries of our sample, households are asked to report the main reason for choosing a place of purchase for each item. Table A1 indicates that households shop at informal stores for lower prices (column 1) and at formal stores for higher quality (column 2). This result holds within households, where formal (informal) purchases are more often motivated by higher quality (lower prices). Indeed we find that in each of the six countries, richer households are up to four times more likely to report quality as the main reason (see the online appendix).[22]

This quality-price trade-off hypothesis implies that formal varieties of a good should be more expensive than informal varieties, reflecting quality differences. In the 21 countries where data permits it, we study the price difference in formal and informal stores within the most narrow good classification and location. We limit ourselves to food goods to mitigate comparability issues and because food is often tax exempt. We estimate the formal price premium in each country:

$$ln(unit\ value)_{igmu} = \beta\ Formal_{igmu} + \mu_{gmu} + \epsilon_{igmu} \tag{3}$$

where $ln(unit\ value)_{igmu}$ is the unit value reported by household i, for good g, in location m, in units u, and $Formal_{igmu}$ equals one if the good is purchased in

[21] Formally we run the regression: $Share\ Informal_{ig} = \beta * ln(expenditure_g) + \alpha_g + \Gamma X_i + \varepsilon_{ig}$ where $Share\ Informal_{ig}$ is the share of household i's informal expenditure on good g and α_g are goods fixed effects. Each observation is weighted by household survey weights and goods expenditure shares. We compute an average goods-level estimate of β for each country.

[22] This is consistent with studies showing richer households spend more on branded goods in the United States (Faber and Fally, 2017) and on high-quality goods in Mexico (Atkin et al., 2018b).

a formal store. μ_{gmu} are fixed effects at the good-location-unit level. On average, food prices are 6.7% higher in formal than informal stores (Table A2). This formal store premium is robust to outliers, excluding self-production, and household characteristics. It is consistent with the hypothesis that formal stores sell high quality varieties at higher prices. Note we understate the true price-premium if other characteristics specific to formal stores reduce prices (e.g. productivity).

This analysis suggests that non-homothetic preferences for quality and goods (especially food vs non-food) contribute to the downward-sloping informality Engel curves, with a more limited role for access. The relevance of these results for policy design depends on the extent to which governments can observe these characteristics (goods, quality) and base policies upon them. On the one hand, governments often set differentiated rates for food goods: as we will see in Section 5, the association between food and informal consumption drastically reduces the scope of such policies. On the other hand, quality is hard to observe and rarely employed in practice as a policy characteristic.

4.3 Consumption Patterns of Food and of Formal Goods

To make consumption taxes more equitable, most countries set reduced rates or fully exempt food.[23] These policies are motivated by the steep downward slope of the food Engel curve, a pattern extensively documented, together with its near log linearity (Anker et al., 2011; Almås, 2012). It is thus relevant to study how the well-established food Engel curve changes once we focus on formal food consumption. Figure 5 show for all countries in our sample the aggregate budget shares and Engel curves slopes, for total food consumption (Figures 5a and 5b), and only for formal food consumption (Figures 5c and 5d). While the total budget share spent on food falls as countries get richer, the budget share on formal food increases. Within country, the food Engel curves' slopes are strongly negative, while the formal food Engel curves have small positive slopes in poor and middle income countries, which become negative in upper-middle income countries.

Figures 5e and 5f also show the aggregate budget shares and Engel curve

[23]Some countries apply reduced rates to all food goods, while others target 'basic' food. For illustrative purpose, we follow the former approach. Targeting narrow items may improve redistribution, but increases misreporting, lowering the effective rate on all formal food goods.

slopes for formal non-food consumption. Unlike formal food, which varies moderately in terms of budget shares and slopes across development, formal non-food consumption strikingly grows over development: its budget share changes from an average of less than 20% in the lowest-income countries to 60% in upper-middle income countries. Similarly, the positive formal non-food Engel curve slopes roughly triple over development.

5 How Progressive are Consumption Taxes?

The consumption patterns in Section 4 determine the equity of taxes on consumption. We first measure consumption taxes' progressivity in the average country, then study how it changes over development, and finally test for robustness.

5.1 Progressivity in the Average Developing Country

Intuition A tax policy is progressive if the effective tax rate (ratio of taxes paid to household income) increases with household income. Following the literature on income tagging (Akerlof, 1978), we focus on the correlation between the budget share spent on a good and household income. The larger this correlation (in absolute terms), the better the consumption of that good is at tagging income. Thus, taxing a good which is positively correlated with income or exempting a negatively correlated good are both progressive policies. To build intuition, consider a good with an Engel curve that is upward sloping and linear with respect to log household income (for example formal goods and non-food goods). The progressivity achieved by taxing this good increases with the slope of its Engel curve and decreases with its aggregate budget share. When two goods have the same aggregate budget share, the one with the steeper Engel curve slope is a better tag of income. Similarly, considering two goods with the same (positive) slopes, the good with the lower budget share is a better income tag, since it is more likely that a purchase of that good is made by a rich household. Thus, taxing this good achieves more progressivity.

Set-up We study the progressivity of three tax policy scenarios. Scenario #1 applies a uniform tax rate on all goods consumed from formal retailers, which illustrates the progressivity of our new informality channel. Scenario #2 sets a

zero tax rate on food and thus only taxes formal non-food consumption. This scenario captures the combined progressivity impact of informal consumption and of tax exempting food. Comparing scenario #2 to #1 reveals the marginal progressivity gain from exempting food, when only formal consumption can be taxed. Scenario #3 applies a zero rate on food goods, but assumes that both formal and informal varieties can be taxed. This scenario corresponds to the unrealistic setting with perfect enforcement that prior studies in developing countries have implicitly focused on. Comparing the progressivity achieved under scenario #3 to the progressivity achieved when moving from #1 to #2 captures the extent to which failing to account for informality leads to erroneous conclusions about rate differentiation's redistributive potential.

For each scenario, we assume that the government sets rates to collect 10% of total consumption in taxes, thus maintaining revenue collected constant across scenarios. These simulations are mechanical: households consumption behavior is not affected by the level of tax rates. Finally, we assume full pass-through of taxes to consumer prices and no savings; we relax these assumptions later.

Results Figure 6 shows, for the three scenarios, the effective tax rates faced by households in each decile of the total expenditure distribution, on average across countries. We obtain three main results. First, taxing only formal consumption makes consumption taxes progressive. Under scenario #1 (red circle line), the effective tax rate sharply increases across deciles: the richest quintile pays twice as much taxes (as a share of income) as the poorest quintile. This is because the informality Engel curves are downward slopping in all countries (Figure 4b). Second, the marginal progressivity achieved by exempting food goods when only taxing formal consumption is limited: when comparing scenario #2 (orange square line) to scenario #1, we find that exempting food barely increases progressivity. This is due to formal food not being an inferior good, contrarily to food: its Engel curve slope is positive in most countries (Figure 5f). Third, the marginal progressivity gains from exempting food in the setting with informality are much smaller than those obtained in the unrealistic scenario #3 (green cross line) with perfect enforcement: a naive policymaker who does not account for informal consumption would overestimate the progressivity gains by a factor of 2.6 (comparing the ratio of top to bottom quintile effective tax rates under the green line to that between

the orange and red lines). This is because food Engel curves' slopes are lower than formal food Engel curves' slopes (Figures 5b and 5d).

5.2 Mechanisms of Progressivity and Patterns over Development

Measuring tagging potential We now explain how the progressivity of taxing different goods changes with development and detail its mechanisms. To characterize the income tagging potential of any good—including goods with downward sloping and non-linear Engel curves—we use the log of the ratio of the budget share spent on that good by households in the richest quintile relative to the poorest quintile. The log transformation implies that a positive value corresponds to a progressive tax base, a negative value to a regressive base, and a zero value to a neutral tax base (i.e. budget shares of rich and poor are equal). It also means that the income tagging potential of goods' consumption is symmetric around zero: a good with a budget share ratio of $1/2$ has the same tagging potential (in absolute magnitude) as a good with a budget share ratio of 2.

Taxing formal consumption Figure 7 presents the tagging potential of the consumption goods considered for taxation. 7a shows that taxing formal consumption is progressive in all 32 countries (log ratio above zero) and the progressivity is markedly higher in low-income countries than middle-income countries. To understand this, consider the patterns of Figure 4: the slope of the informality Engel curve grows (in absolute value) over development and increases progressivity, but this slope effect is dominated by the base effect whereby the large reduction in informal budget share over development decreases progressivity.

Figures 7b and 7c study the progressivity of taxing formal food and taxing formal non-food consumption over development. The results for formal food are intriguing (Figure 7b): in the poorest countries, formal food is a progressive tax base; its progressivity falls over development, and taxing formal food becomes regressive in upper middle-income countries. This is due to the change in sign of the formal food Engel curve slope over development, which goes from small positive values to negative values; and, the increase in the aggregate formal budget share, which is very small in the poorest countries and rises over development (Figures 5c and 5d). Formal non-food is positively correlated with income in all countries and its progressivity slightly declines over development as its aggregate

budget share increases (Figures 5e and 5f).

Figure 7d directly compares the progressivity of formal food (dotted orange line) and formal non-food (solid orange line) over development. These two goods are equally strong tags of income in the poorest countries: food consumption in formal retail accrues disproportionately to high-income households, thus exempting food from taxes benefits rich households and does not improve progressivity. This explains why the marginal progressivity gain from exempting food is so limited in the average country. However, along the development path, the tagging potential gap widens between formal non-food and formal food consumption, and tax exempting food leads to progressivity gains in middle-income countries.

Comparison with unrealistic enforcement scenario Finally, we consider the progressivity gains in the unrealistic setting with perfect enforcement capacity and compare them to the gains in the setting with informal consumption. Figures 7e and 7f show the progressivity of taxing food and non-food in the naive scenario where informal consumption is taxable. Taxing food is regressive in all countries, and increasingly so over development, as the aggregate budget share spent on food decreases and the food Engel curve's slope remains constant (Figures 5a and 5b). Symmetrically, taxing non-food consumption is progressive everywhere.

Figure 7d pools the log ratios from all scenarios in one graph, allowing us to compare progressivity gains from tax exempting food in the informality constrained setting (orange lines) versus the naive setting (green lines). When food is exempted, only non-food goods are taxed; thus the progressivity achieved can be measured as the difference between the tagging potential of non-food goods (solid lines) and food goods (dotted lines). This gap is smaller in all countries in the setting with informality (orange lines) than without informality (green lines). This result shows that, in both low and middle-income countries, the progressivity gains from exempting food is always overestimated in the unrealistic setting with perfect enforcement; in practice, incorporating informal consumption dampens the progressivity gains of this policy tool in all developing countries.

Would a naive policymaker overestimate the progressivity gains of exempting food more for low or for middle-income countries? To answer this, we look at a triple difference: the change over development in the difference between the orange lines' gap and the green lines' gap (Figure 7d). Both gaps widen over

development—tax exempting food brings more progressivity over development in both the informality constrained and naive worlds—but the gap between food and non-food widens faster in the informality constrained scenario. Thus, not accounting for informal consumption leads to a particularly erroneous assessment of the progressivity gains from food exemptions in lower income countries, and the 'assessment error' decreases with development.

5.3 Robustness

Alternative formality assignment We test the robustness of our results to the alternative assignment rules described in Section 3, which relax the assumption of a common tax-status by store in all countries, and allow informal stores to have formal suppliers. Results are in Table A3 and Figure A5. Our qualitative results are robust to these extensions; the largest quantitative impact is a 20% decrease in the average progressivity of a uniform rate when allowing for formal suppliers.

Distributional savings rates Our baseline results use total expenditure to proxy for income, thus implicitly assuming that households do not save. Savings decrease effective consumption tax rates (as savings are not taxed) and reduce progressivity if savings rates increase with income.[24] The distribution of savings by income levels is inaccurate in expenditure surveys, especially in developing countries where income is poorly measured (Deaton, 1997). Instead, we use the Global Findex Database (Demirguc-Kunt et al., 2018) to measure the share of households that save by income decile. We then apply a homogeneous savings rate (conditional on saving) to match aggregate savings in the economy: this produces a country-specific distribution of savings by household income. In Table A3 column 4, we show that allowing for distributional savings slightly decreases progressivity in all scenarios, but our main findings are unchanged.

6 Optimal Consumption Tax Policy with an Informal Sector

This section studies the implications of the novel consumption patterns for optimal tax policy. We extend the multi-person Ramsey model of commodity taxation

[24] Annual income overstates consumption taxes' regressivity: consumption depends on lifetime income, which is less volatile than annual income (Poterba, 1989).

(Diamond, 1975) to a context in which informal varieties cannot be taxed. We derive optimal tax rates for three policy scenarios which mirror Section 5, and establish how optimal rates change over development. Studying optimal tax policy allows us to model behavioral responses to taxes; differentiate tax rates between food and non-food in general; and, study inequality reductions (in Section 7).[25]

6.1 Set-up

Household preferences There is a continuum of mass 1 of households i with heterogeneous exogenous incomes y^i. Households have preferences over j goods, and for each good over two varieties v, which are imperfect substitutes. $v = 0$ indicates a variety produced in the informal sector, $v = 1$ a variety produced in the formal sector. Unless specified, informal varieties cannot be taxed. Producer prices q_{jv} are exogenous, consumer prices are given by $p_{j1} = q_{j1}(1 + t_j)$, where t_j is the tax on good j, and $p_{j0} = q_{j0}$. $v(p, y^i)$ is the indirect utility of household i, s^i_{jv} the budget share spent by household i on variety v of good j, $s^i_j = s^i_{j0} + s^i_{j1}$ the budget share spent on good j, and ϵ_j the price elasticity of demand for good j.

We assume that compensated price elasticities of demand for goods are equal across households, goods, and over development. We set elasticities of substitution across goods to zero, but set a positive cross-price elasticity of demand across varieties. This allows us to focus on households' substitution across varieties within a good.[26] We allow income elasticities to vary across goods and varieties, but assume income effects are fixed over development. With this structure of preferences, we can determine how uncompensated price elasticities, which drive the efficiency cost of taxation, vary across goods and over development. In Appendix D, we show that the uncompensated price elasticity of demand for a formal variety of a good, ϵ_{j1}, can be expressed as:

$$\epsilon_{j1} = \epsilon^C - \eta_{j1} s_{j1} - 2\tilde{\epsilon}^C \alpha_j \tag{4}$$

This elasticity captures the efficiency cost of only taxing the formal variety and is composed of three terms. The first is the compensated price elasticity of demand for a good, ϵ^C. The second is an income effect driven by the income

[25] We show results for many goods rate differentiation in Section 7.3

[26] The cross-variety price elasticity is assumed invariant across goods and over development.

elasticity for the formal variety η_{j1} and its budget share s_{j1}. The third depends on the compensated cross-price elasticity of demand, $\tilde{\epsilon}^C$, and the share of informal consumption in total consumption of good j, α_j. As the price of the formal variety rises, households substitute to informal varieties: this raises the formal variety's price elasticity, the more so the larger the cross-variety substitution (higher $\tilde{\epsilon}^C$).

Government preferences Government chooses the tax rates t_j to maximize:

$$W = \int_i G(v(p, y^i))di + \mu \sum_j t_j q_{j1} x_{j1} \tag{5}$$

where $x_{j1} = \int_i x^i_{j1}(p, y^i)$ is total consumption of the formal variety of good j. Government preferences are characterized by μ, the marginal value of public funds, and $G()$, an increasing and concave social welfare function. We write g^i household i's social marginal welfare weight, which represents how much the government values giving an extra unit of income to household i, and $\bar{g}$ its average (see Saez and Santcheva, 2016). We assume g^i falls with income, and $\mu = \bar{g}$. This corresponds to a government which taxes only if it enables redistribution.

6.2 Optimal Tax Policy over Development

We study optimal tax policy changes over development, which we model as a proportional increase in all households' income (such that the distribution of household income is unchanged). We assume Engel curves are approximately linear in log income (relaxed in the calibration). We first consider optimal uniform taxation when only formal varieties are taxed. We then study optimal rate differentiation between food and non-food: first in the implausible setting of perfect enforcement; then, in the realistic setting where only formal varieties are taxed.

6.2.1 Optimal Uniform Commodity Taxation

We first assume that the government levies a uniform tax on all goods, $t_j = t$, $\forall j$, but cannot tax informal varieties. Writing $\tau = \frac{t}{1+t}$, welfare maximization yields:

$$\tau^* = \frac{\int_i (\bar{g} - g^i)\phi^i \frac{s^i_1}{s_1} di}{-\epsilon_1 \bar{g}} \tag{6}$$

where $s_1 = \sum_j \int_i s_{j1}^i di$ is the aggregate budget share spent on all formal varieties, $\phi^i = \frac{y^i}{\bar{y}}$ is the ratio of household i's income relative to average income $\bar{y}$ and ϵ_1 is the uncompensated price elasticity of demand for all formal varieties. Equation (6) shows that the optimal uniform rate is increasing in the co-variance between household income and formal budget shares: the more richer households spend on formal varieties relative to the poor, the more redistribution is obtained from taxing only formal varieties. The optimal rate decreases in the absolute value of the uncompensated price elasticity of demand for formal varieties: the more households respond to changes in formal prices by consuming fewer formal varieties, the higher the efficiency cost of taxing only formal varieties.

The change in the optimal uniform rate over development is given by:

$$\frac{\partial \tau^*}{\tau^*} = \frac{\int_i (\bar{g} - g^i)\phi^i \frac{s_1^i}{s_1}(\frac{\partial s_1^i}{s_1^i} - \frac{\partial s_1}{s_1})di}{\int_i (\bar{g} - g^i)\phi^i \frac{s_1^i}{s_1} di} + \frac{\partial \epsilon_1}{\epsilon_1} \tag{7}$$

Proposition 1. ***Optimal uniform taxation when only formal varieties are taxed***

- *The equity gain (first term) from taxing all goods uniformly falls over development as long as: i) the formal Engel curve is upward sloping, ii) the aggregate formal budget share increases more than the slope of the formal Engel curve.*

- *The efficiency cost (second term) of taxing all goods uniformly is decreasing over the development path as long as $\tilde{\epsilon}^C > \frac{\eta_1}{2}$, where η_1 is the income elasticity of demand for all formal varieties $\tilde{\epsilon}^C$ is the cross-variety price elasticity of demand.*

Proof: Appendix D. The first part formalizes the intuition from Section 5 for how changes in aggregate formal budget shares and Engel curve slopes affect the progressivity of taxing formal varieties. The second part states the conditions under which efficiency considerations push the optimal uniform rate up over development. The increase in aggregate formal consumption share over development reduces the substitution opportunities towards informal varieties; this lowers the efficiency cost of taxing formal varieties. Simultaneously, the growth in formal consumption increases the responses to changes in prices due to income effects, leading to higher efficiency costs. The first effect dominates as long as $\tilde{\epsilon}^C > \frac{\eta_1}{2}$. Overall, large informal sectors in poor countries increase both the equity gains and the efficiency cost of consumption taxes, relative to richer countries.

6.2.2 Optimal Rate Differentiation when all Varieties can be Taxed

In the case where the government sets different rates on food and non-food goods but can tax both formal and informal varieties, the optimal rate on good j is:

$$\tau_j^* = \frac{\int_i (\bar{g} - g^i)\phi^i \frac{s_j^i}{s_j} di}{-\epsilon_j \bar{g}} \tag{8}$$

This expression shows that the optimal rate is increasing in the co-variance between household income and budget share spent on good j. In this case, the change over development in the optimal tax on food relative to non-food is

Proposition 2. ***Optimal rate differentiation when all varieties are taxed***

- *The equity gain from taxing food less than non-food goods is increasing over the development path as long as: i) food Engel curves are downward sloping, ii) aggregate food budget shares decrease, iii) the aggregate food budget share is lower than the aggregate non-food budget share, iv) food Engel curves do not flatten too much.*
- *In addition, the efficiency cost of taxing food less than non-food increases with development as long as the non-food budget shares increase.*

Proof: Appendix D. Intuitively, for given Engel curve slopes, the redistributive gain from rate differentiation is minimized when food and non-food aggregate budget shares are equal: in this case, observing a food or non-food purchase yields little information about households' income, and differentiating rates has little redistributive effect. This is the case in the poorest countries in our sample where food and non-food goods are consumed in equal proportions (5a). As countries grow, the food budget shares fall such that food purchases become a better tag for household income. Efficiency considerations increase the optimal rate on food relative to non-food over development (decrease rate differentiation). This is due to the income effect from the fall in the average budget share spent on food, while that spent on non-food goods increases as countries grow.

6.2.3 Optimal Rate Differentiation when only Formal Varieties are Taxed

Finally, in the realistic scenario where informal varieties cannot be taxed, the optimal rate on good j when only variety $j1$ is taxed is:

$$\tau_j^{**} = \frac{\int_i (\bar{g} - g^i)\phi^i \frac{s_{j1}^i}{s_{j1}} di}{-\epsilon_{j1}\bar{g}} \tag{9}$$

Proposition 3. ***Optimal rate differentiation when only formal varieties are taxed***

- *The equity gain from taxing food less than non-food increases over development as long as: i) the slope of the Engel curve for formal food varieties decreases relative to that for formal non-food varieties, ii) the aggregate budget share of formal non-food varieties does not increase much faster than the aggregate budget share of formal food varieties.*
- *The efficiency cost of taxing food less than non-food rises with development as long as the informal share of food consumption falls faster than that of non-food consumption.*

Proof: Appendix D. As discussed in Section 5, formal food is equally progressive as formal non-food in the poorest countries. Over development, the Engel curve slope of formal non-food varieties rises, while that on formal food varieties falls. This increases the redistributive gain from reducing the rate on food relative to non-food, as long as the aggregate budget share of formal non-food does not increase too much relative to that of formal food. In contrast, efficiency considerations push relative food rate reductions down over development, since the efficiency cost of taxing only the formal variety of a good rises with the share of informal consumption in total consumption of that good (equation 4). Over development, informal shares fall, lowering the efficiency cost of taxing both food and non-food goods. However, they fall faster for food than for non-food (Figure A6), implying that the efficiency cost of taxing formal food drops faster than that of taxing formal non-food over development.

7 Calibrated Tax Rates and Inequality Reduction

We calibrate the optimal commodity tax rates and measure inequality reduction. We then extend our analysis to rate differentiation across many goods and direct taxes. Finally, we discuss our incidence setting and broader welfare impacts.

7.1 Optimal Tax Rates

We calibrate the optimal tax rates defined in equations (6), (8) and (9). Table 3 summarizes our choices of parameters. We relax our theoretical assumptions that

Engel curves are log-linear and that inequality is fixed, using instead the observed budget shares and income distributions in each country. We use the budget shares for each good, variety and country, and the slopes of their Engel curves to calibrate income elasticities. A key parameter is the cross-variety compensated price elasticity which governs the substitution between formal and informal varieties: we consider a range of [1,2] in line with estimates in Faber and Fally (2017) and Atkin et al. (2018b) and use 1.5 as our baseline value. We set a value of -0.7 for the own-price compensated elasticity of goods. Together, these parameters yield values for the own-price uncompensated elasticity of goods in the $[-2.2, -0.7]$ range, consistent with the literature (Deaton et al., 1994). Finally, we calibrate the government's social welfare weights such that the optimal uniform rate is on average 18% across the countries in our sample. This matches the statutory consumption tax rates often set in practice (See appendix D.2 for more details).

Figure 8a shows optimal uniform rates over development, when informal varieties are not taxed (equation 6). In our baseline scenario, rates increase from 15% in the poorest countries to 20% in upper-middle income countries. This is because, over development, the efficiency gains due to the shrinking size of the informal sector overcompensate the falling progressivity from taxing formal consumption. Figure 8b shows that, as expected, uniform rates would be higher in poorer countries without efficiency costs. The increase in rates over development holds for substitution elasticities between 1 and 2 (Figures 8c and 8d).

Figure 9 plots for each country the ratio of optimal food to non-food rate (the rate differentiation) in relation to development (equations 8 and 9). We fix the elasticity of substitution across varieties at 1.5. Figure 9a refers to the realistic scenario where only formal varieties are taxed, and Figure 9b to the naive scenario where all varieties can be taxed. The comparison shows that while a naive policymaker would reduce the extent of rate differentiation as its country grows, taking into account informal consumption yields the opposite result: rate differentiation increases as a country gets richer. The optimal tax rate on food relative to non-food goods is 80% in the poorest countries, versus 60% in richer countries. This pattern is robust to changing the elasticity of substitution (Figure A7).[27]

[27]While our result is derived with a stylized production side, it is consistent with a theoretical literature (Munk, 1980) which shows that, so long as one commodity remains untaxable, rate differentiation remains optimal even in general equilibrium settings with many production factors.

7.2 Inequality Reduction from Optimal Consumption Taxes

Equipped with these optimal rates, we can now determine the inequality reduction from consumption taxes, which we measure as the percent change in Gini from the pre-tax to the net-of-tax expenditure distribution. We only consider the direct effect of the tax system; since we do not reallocate collected revenues, inequality reductions depend on the level differences in effective tax rates paid by poor versus rich households. In the case of a uniform tax rate, the change in inequality depends on the level of the optimal rate, the progressivity of taxing formal consumption, and the share of formal consumption. For differentiated rates, inequality reduction depends, in addition, on the progressivity gains from taxing formal non-food more than formal food, and the size of the respective bases.

Figure 10 shows for each country the percent change in Gini from applying optimal uniform taxes (Figure 10a) and optimal food and non-food rates (Figure 10b). First, the inequality reduction achieved in developing countries due to informal consumption is substantial, at 2% on average. Redistributive gains increase over development, from 1% in the poorest countries to 3% in upper-middle income countries. This is due to both higher tax rates and higher formal budget shares, which overcompensate the falling progressivity over development of taxing formal consumption. Second, the marginal redistribution gains from different rates on food and non-food is limited: on average, the Gini reduction goes from 2% to 2.7%. Thus, in the average country, consumption taxes primarily redistribute through underlying differences in informal consumption rather than policy determined rate policies. However, the marginal inequality reduction from rate differentiation increases over development, owing to stronger levels of rate differentiation and the increased progressivity of reduced rates on formal food.

To gauge the magnitude of these results in relation to previous work, we compare them to the data from Commitment to Equity (CEQ) (Lustig, 2018). The CEQ studies actual tax policies (instead of optimal ones) in 25 developing countries, and does usually not account for informal consumption; notwithstanding these differences, the CEQ results reflect the consensus view on the quantitatively limited redistributive role of consumption taxes. Indeed, we find that consumption taxes reduce inequality by 2-2.7%, while the CEQ's average estimate is 0.6%. In fact, our inequality reduction result is more comparable to the reduction achieved by *actual* direct taxes (income taxes and social security) in CEQ, which

is 2.6% on average. Naturally, the redistributive potential of the direct tax system is constrained in developing countries, since it only covers the small share of the workforce which is not self-employed (Jensen, 2019).

Table A4 reports robustness checks for the inequality reduction. Panel (a) shows the average Gini reduction and Panel (b) the ratio of Gini reduction in middle-income countries over that of low-income ones. First, we vary the cross-variety price elasticity of demand: a lower value yields more inequality reduction as governments can set higher taxes without inducing much substitution towards informal varieties. This mainly benefits low-income countries with larger informal sectors. Second, we show that the results are robust to the checks implemented in Section 5. Using data-driven country-specific formality assignments leaves our results qualitatively unchanged. Allowing for some pass-through of taxes to prices in the informal sector via formal suppliers has two opposite effects: it reduces the progressivity of consumption taxes by indirectly taxing informal consumption but increases the size of the formal tax base and thus the average effective tax rates. In practice the first effect slightly dominates. Finally, introducing distributional savings leads to 5% less inequality reduction.

7.3 Extensions

Further rate differentiation So far, we considered policies that set at most two tax rates: on food and on non-food goods. To a first order, this highlights the main equity motivated consumption tax policy observed across countries. To study how further rate differentiation impacts inequality, we calibrate optimal tax rates for each of the twelve main goods category of the UN classification (food, clothing, etc.) at the country level. Figure A8 shows that rate differentiation across the twelve goods increases as countries get richer, mirroring the pattern with only two rates. The average inequality reduction achieved by rate differentiation across the twelve main goods category is 3.2%, which is approximately 20% larger than that achieved by simple differentiation between food and non-food (table A4). Since multiple rates also induce tax evasion and administrative costs (Ebrill and Keen, 2001), this result further advocates for limited rate differentiation in developing countries; particularly in low-income countries, where these additional tax instruments have no further impact on inequality (Figure A8).

Interaction with direct taxes Our finding that optimal indirect taxes are redistributive is derived in a model without direct taxes. A central result in public finance is that redistribution is better achieved through direct rather than indirect taxes (Atkinson and Stiglitz, 1976). However, this result assumes that income taxes are perfectly enforceable, which is at odds with developing countries' reality (Jensen, 2019). When income taxes can be evaded, indirect tax instruments serve a redistributive role (Huang and Rios, 2016). Appendix D.3 extends the optimal commodity tax model to a context where the government also levies a personal income tax (PIT). We focus on how existing PITs impact optimal commodity tax redistribution, characterizing the PIT with exogenous parameters from Jensen (2019): a top tax rate and an exemption threshold.[28] Jensen (2019) shows that top marginal tax rates are stable over development but the PIT base gradually broadens. The PIT lowers disposable income at the top of the distribution, which impacts optimal commodity taxes through two mechanisms. First, it increases the welfare weights of rich households and reduces the welfare gains from taxing progressive goods. Second, income effects lower rich households' consumption of those goods and reduce their tagging potential. The broadened PIT base over development implies that both effects are stronger in middle-income countries.

Figure A9 shows that the presence of a PIT lowers optimal uniform consumption tax rates from 18% to 16.8% on average, and most in middle-income countries with broader PIT bases. To calculate the inequality effect of consumption taxes, we first apply the income tax and then compute the change in post-PIT Gini from optimal commodity taxes. Accounting for PIT leads the average inequality reduction from consumption taxes to fall from 2.0% to 1.7% with a uniform rate, and from 2.7% to 2.3% with differentiated rates (Table A4). Inequality reductions from consumption taxes continue to rise with development (Figure A9).

7.4 Discussion

Incidence Our main results are derived with stylized incidence effects. In particular, our formulas are consistent with a setting of monopolistic competition between formal and informal retailers, where the incidence of taxes is passed

[28] We model an ideal PIT: all households above the threshold fully comply and pay the top marginal rate. This overstates (understates) the redistributive potential of PIT (consumption taxes). Indeed, our simulations show a large Gini reduction from the PIT system —5.5% on average.

on to consumer prices. While the Mexican evidence is consistent with this setting, we discuss additional incidence considerations. In practice VAT incidence might be shared among consumers, firm owners and workers (Benzarti and Carloni, 2019). In our setting, part of the VAT burden might be passed on to formal store workers or absorbed by their owners. Our result—that consumption taxes are progressive—holds in this richer setting as long as formal store owners and workers are richer than the average household. We find that this is the case for workers in our data.[29] Incidence effects can also occur through entry and exit of firms, which our model abstracts from. A rate increase may cause some formal retailers to become informal, putting downward pressure on informal prices. Additionally, a higher VAT rate could increase demand for goods in informal stores, putting upward pressure on their prices but benefiting informal retail owners and workers. Thus additional incidence channels are unlikely to overturn our results.

Finally, informal retailers may sometimes pay market fees and other licence or business taxes, while formal retailers may face additional taxes on corporate income and property. Accounting for these additional taxes most likely leads to a larger overall effective tax rate for formal stores than for informal stores. If these taxes were passed on to consumers, they would increase tax progressivity.

Welfare and informal consumption Our results show that informal consumption plays a redistributive role, but other features of informal consumption, not captured here, also determine its societal desirability. Studies on food security show that the many locations of informal retailers improves access to fresh produce for poor households (Crush, 2018). Informal retailers offer products in smaller bundles and permit credit, allowing households with variable budgets to make a broader range of purchases. However, informal retailers are also characterized by smaller floor space and limited access to storage and refrigeration, causing food hazards and lower nutrient quality (Hopkins, 2006). The traditional retail segment also constitutes a source of income for 15-20% of the active population in many developing countries, and these jobs can be displaced by foreign retailers' entry. At the same time, large modern retailers often pay higher wages (Cardiff-Hicks et al., 2014). The absence of a consensus on the societal desirability

[29] In 19 countries we observe the labor formality of the household head (defined as contributing to health or pension funds). Formal retail workers are 50% richer than the median household on average, and the income difference is most pronounced in poorer countries (Figure A10).

of traditional retail is reflected in the ongoing debate over regulating modern retail entry, and country policies vary from full liberalization (in Latin America and Eastern Europe) to prohibitive barriers (in Southeast Asia). Our study contributes to this debate by investigating the public finance merits of informal retailing.

8 Conclusion

In this paper, we harmonize expenditure surveys from 32 developing countries which contain the store type for each transaction. We assign store types to the informal or formal sector, using a robust assignment rule, and measure the informal budget share at the household level. We find that informal budget shares steeply fall with household income, in every country. Contrary to the consensus, consumption taxes are progressive in developing countries and optimal commodity taxes lower inequality by 2-3%, as much as actual personal income taxes.

Our results have sharp implications for the use of reduced rates on necessities (food in particular), a widespread policy around the world. We show that differentiating rates across goods has limited redistributive potential once informal consumption is accounted for, particularly in low-income countries. In practice, increasing tax rates on necessities is often met with fierce resistance: a feasible, equity improving policy would need to combine tax rate equalization with compensation to the poorest households through transfers (Hanna and Olken, 2018).

Our analysis is consistent with the view that formality in traditional and modern stores is stable across developing countries, such that the increased enforceability of consumption taxes over development is mainly driven by the growth of modern retailing rather than by changes in enforceability within store type. Indeed, recognizing how taxing it is to tax small firms, tax administrations in developing countries focus enforcement on large firms (Basri et al., 2019) and exempt firms below a threshold (Keen and Mintz, 2004). Growth of digital technologies may lower enforcement and compliance costs and make it worthwhile to bring smaller firms into the tax net (Gupta et al., 2017). Our results do not imply that efforts to tax small firms should be abandoned, but caution that the benefits from reducing the size of the informal sector should be weighed against equity costs. Policy decisions—such as the location of the exemption threshold—should consider distributional impacts in addition to compliance constraints.

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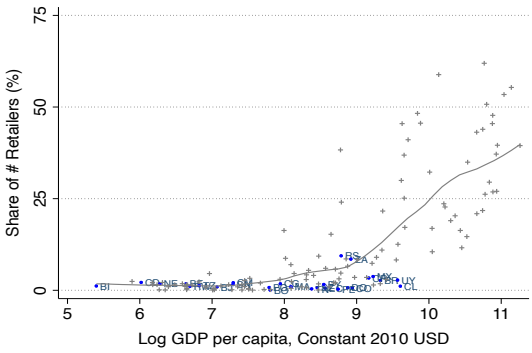
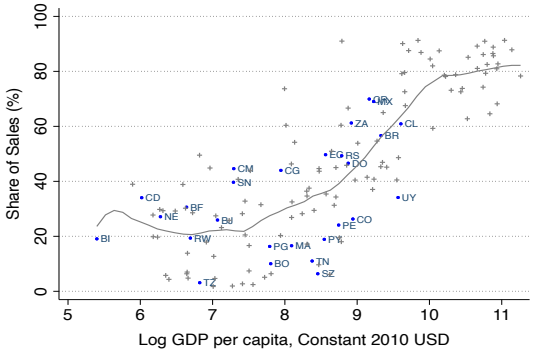
Figure 1: Characteristics of Modern and Traditional Retailers across Countries

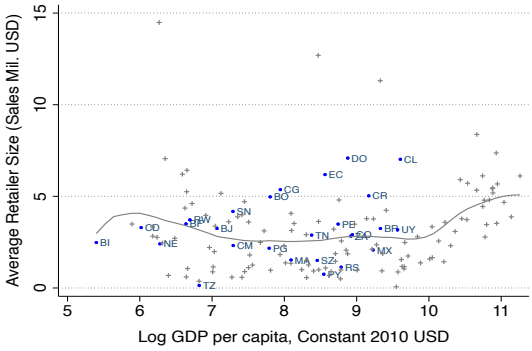
(a) Modern Retailers, Share of # Retailers



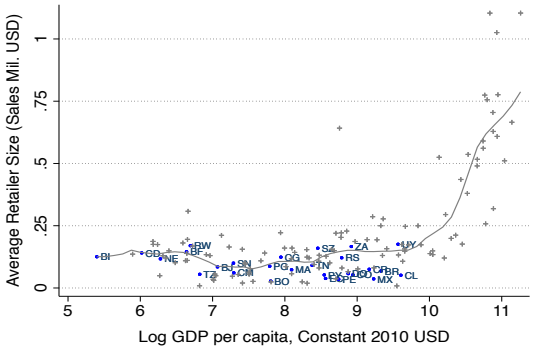
(b) Modern Retailers, Share of Market Sales



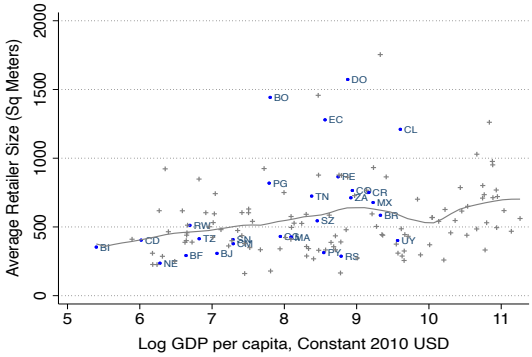
(c) Modern Retailers, Average Sales



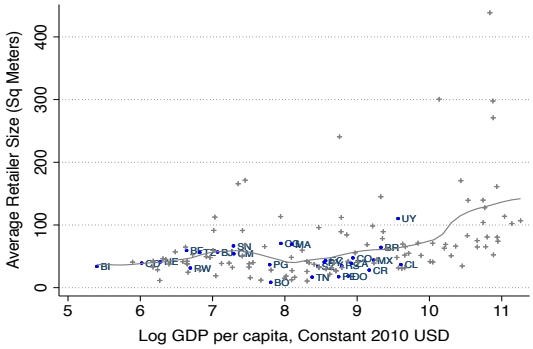
(d) Traditional Retailers, Average Sales



(e) Modern Retailers, Average Space



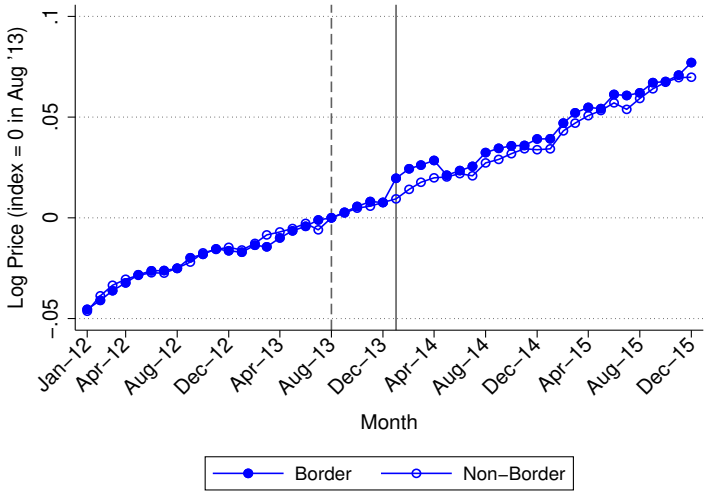
(f) Traditional Retailers, Average Space



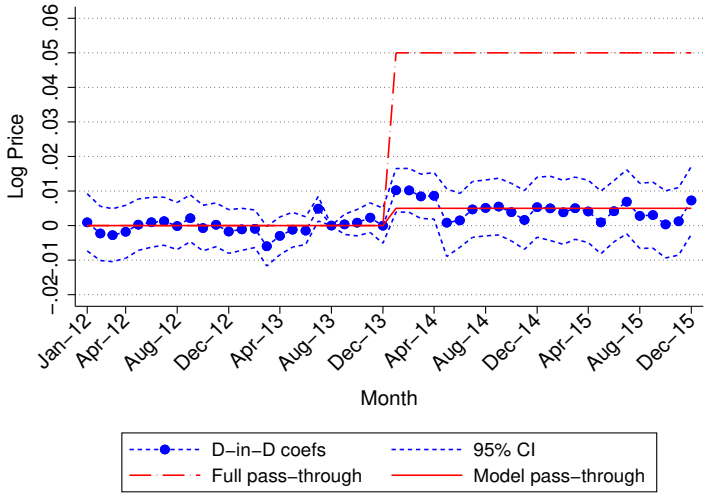
These panels plot characteristics of modern and traditional stores in 2014 across 189 countries at different levels of log GDP per capita, as discussed in Section 3.1. All figures are based on retail reports from Euromonitor International. Traditional stores include non-brick and mortar stores and small corner and convenience stores. Modern stores include specialized stores and large stores. Panels a-b plot plots the modern share of number of retailers and total retail sales. Panels c-d plot the average sales size for modern and traditional stores, measured in USD millions. Panels e-f plot the average floor space of modern and traditional stores, measured in square meters. The blue dots denote the 32 countries in our data, where we observe store type for each transaction.

Figure 2: Pass-through in Informal Retailers: Evidence from Mexican VAT Reform

(a) Raw Price Data by Area

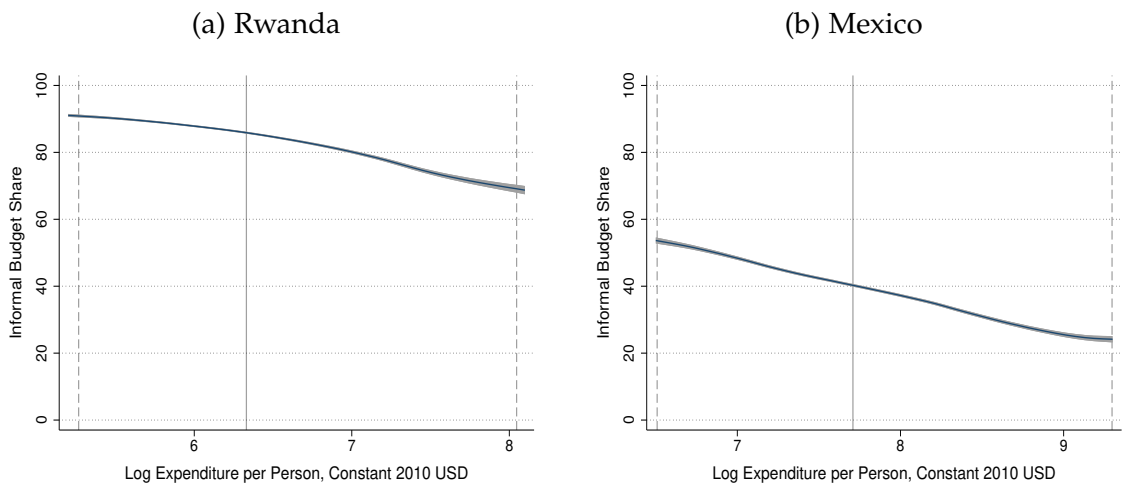


(b) Difference in Differences Coefficients



Panel A shows average monthly prices for informal retail stores by area, as discussed in Section 3.3. Each line represents the log average price in all informal retail stores in border or non-border areas, indexed to equal 0 in August 2013. The vertical lines indicate the reform relevant dates: the dashed line denotes the announcement date (August 2013) and the solid line denotes the reform date (January 2014) where the VAT rate was increased from 11% to 16% in border areas. Panel B shows the difference in differences regression coefficients β_t from estimating equation 1. The sample has 409,864 product-location-month price observations between January 2012 and December 2015. Standard errors are clustered at the product-location level. The dashed red line indicates full pass-through, while the solid red line indicates the pass-through predicted under the monopolistic competition with formal suppliers with the observed formal input-share in Mexican informal stores (10%).

Figure 3: Selected Informality Engel Curves



These panels show the local polynomial fit of the informality Engel Curves in Rwanda and Mexico, constructed from household level data, as discussed in Section 4.1. Informal budget share is on the vertical axis. Per person total expenditure on the horizontal axis is measured in log. The shaded area around the polynomial fit corresponds to the 95% confidence interval. The solid vertical line denotes the median of each country's expenditure distribution, while the dotted lines correspond to the 5th and 95th percentiles. See the online appendix for each country's IEC.

Figure 4: Informal Expenditure Across Countries

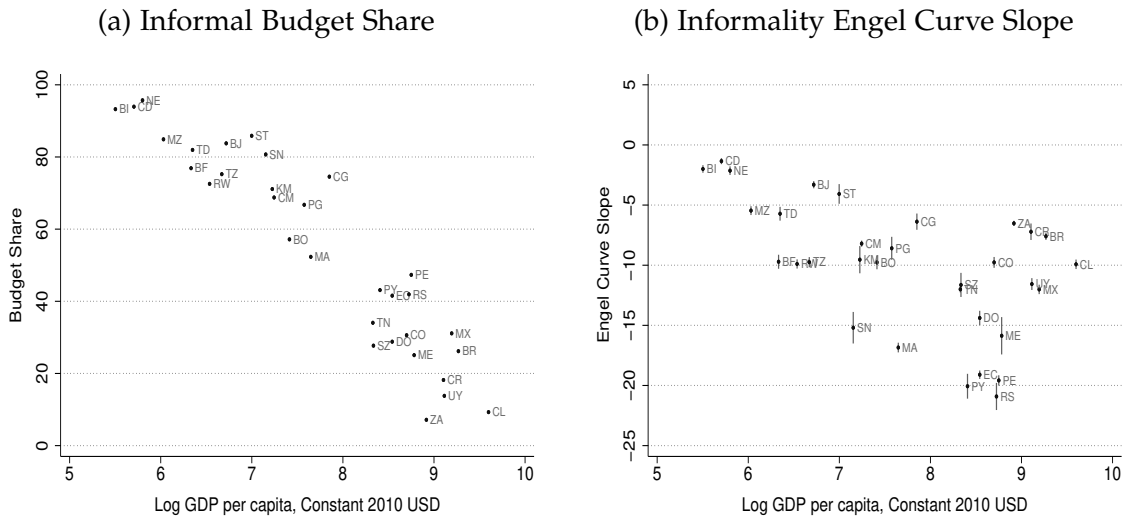
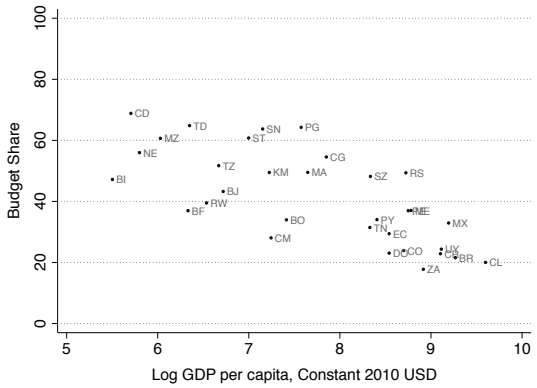


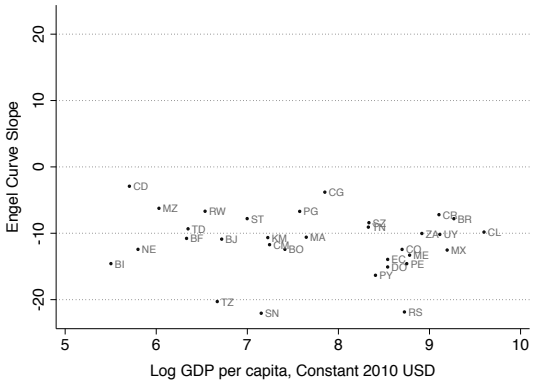
Figure 4a plots the aggregate informal budget share on log GDP per capita for each country, as discussed in Section 4.1. Figure 4b shows the slope of the informality Engel curves on log per capita GDP. The bars denote the 95% confidence interval of the slope coefficient.

Figure 5: Expenditure on Different Goods Across Countries

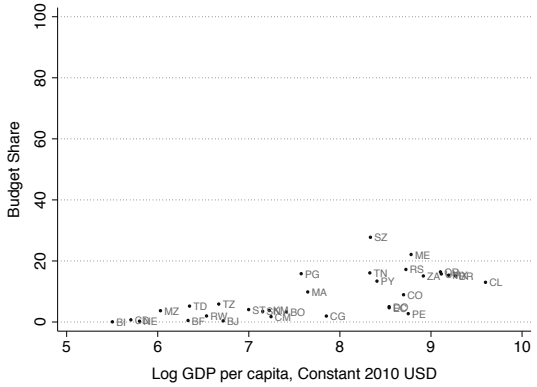
(a) Food Budget Share



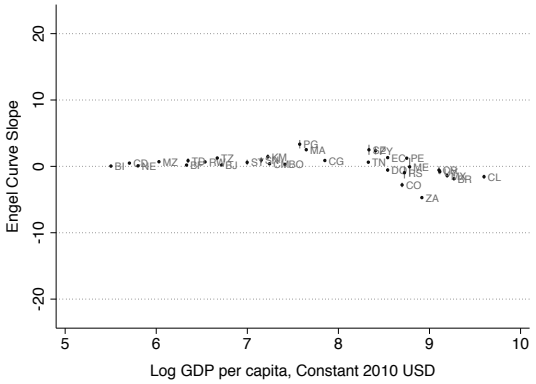
(b) Food Engel Curve Slope



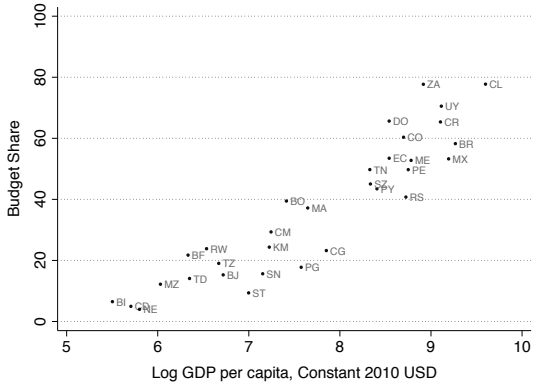
(c) Formal Food Budget Share



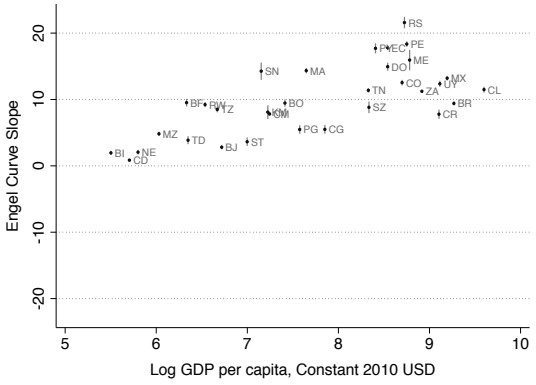
(d) Formal Food Engel Curve Slope



(e) Formal Non-Food Budget Share

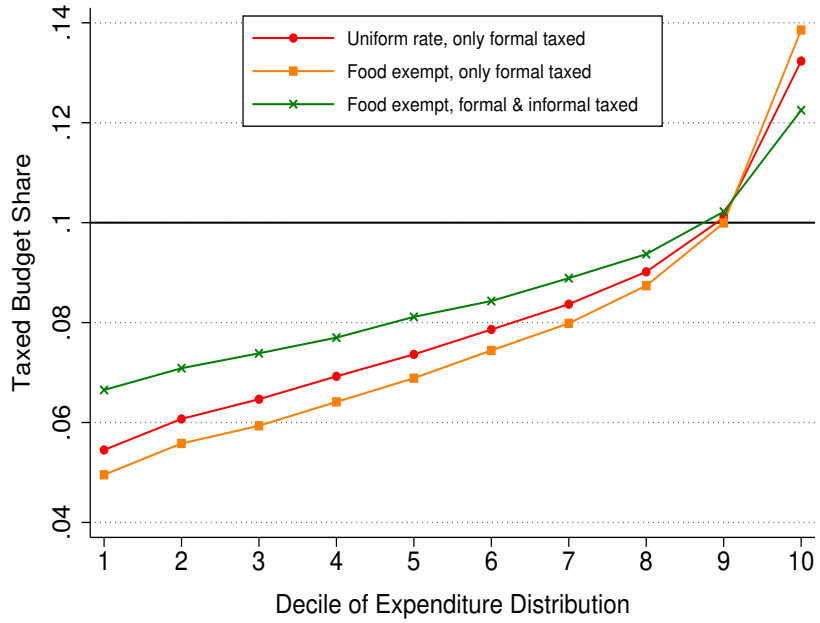


(f) Formal Non-Food Engel Curve Slope



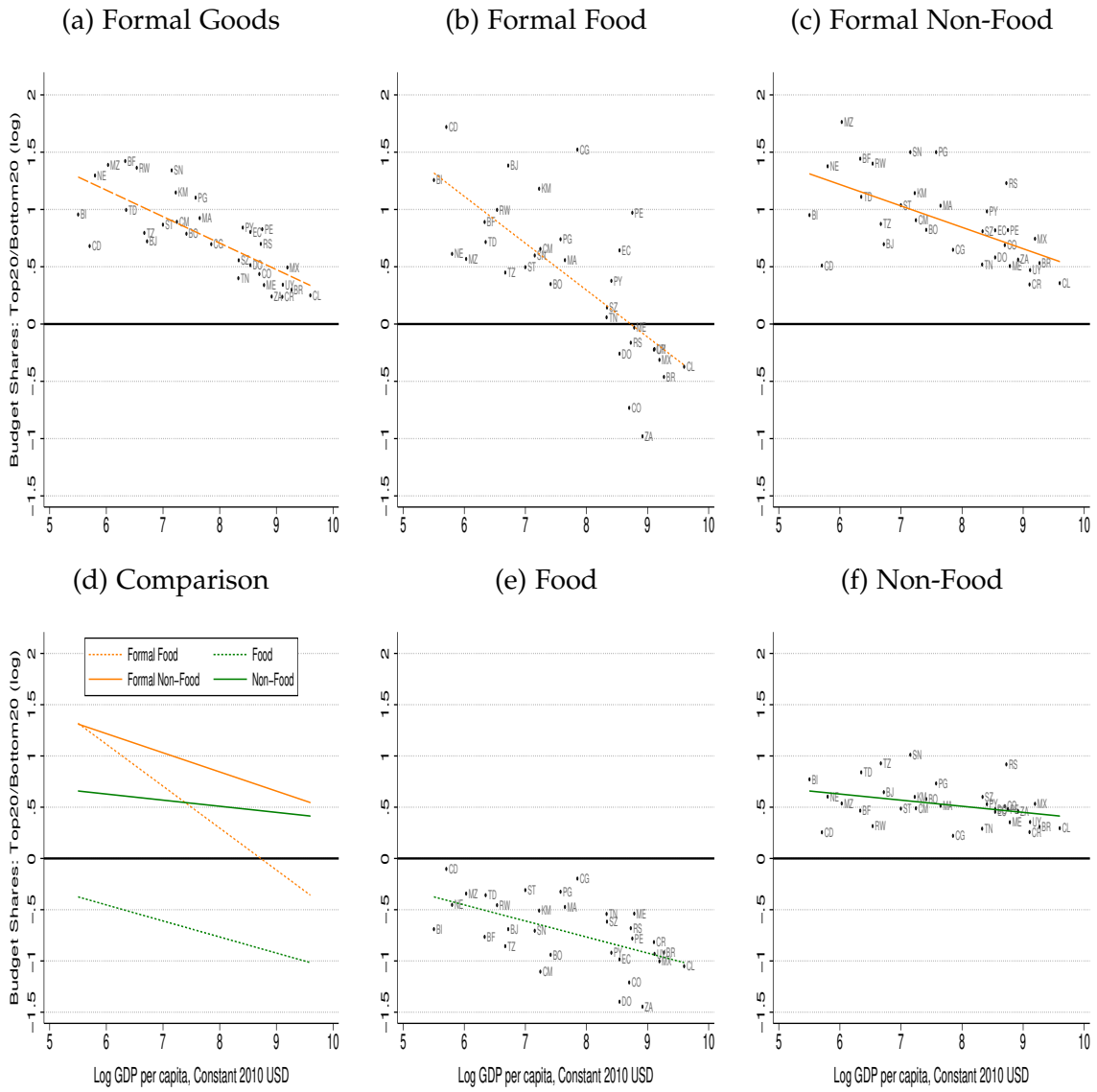
This figure shows the aggregate budgets shares (left panels) and Engel curves slopes (right panels) on log GDP per capita for three types of consumption goods, as discussed in Section 4.3: food, formal food and formal non-food.

Figure 6: Progressivity of Tax Policy Scenarios in the Average Country



This figure plots the share of expenditures paid in taxes (effective tax rates) by decile, for the three tax scenarios described in Section 5.1. The three scenarios are simulated in all 32 countries and each point corresponds to the average effective tax rate of each decile across countries. Each scenario imposes that the government collects 10% in taxes and assumes that households do not respond to taxes (mechanical simulations). The black horizontal line shows the effective tax rate when all consumption—formal and informal—is assumed taxable, at a uniform rate. The red circled line corresponds to a scenario where a uniform tax is levied on all goods, but where informal consumption is untaxed (scenario #1). The green crossed line corresponds to the counterfactual scenario with perfect enforcement: food is exempted, but informal consumption is assumed taxable (scenario #2). The orange squared line corresponds to a scenario where informal consumption is untaxed and food goods are tax exempted (scenario #3).

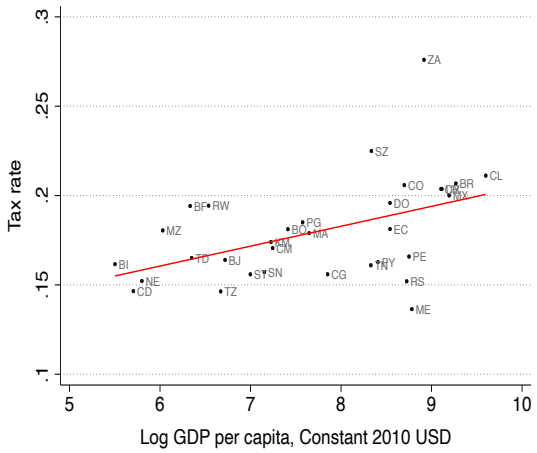
Figure 7: Progressivity of Taxing Different Goods across Countries



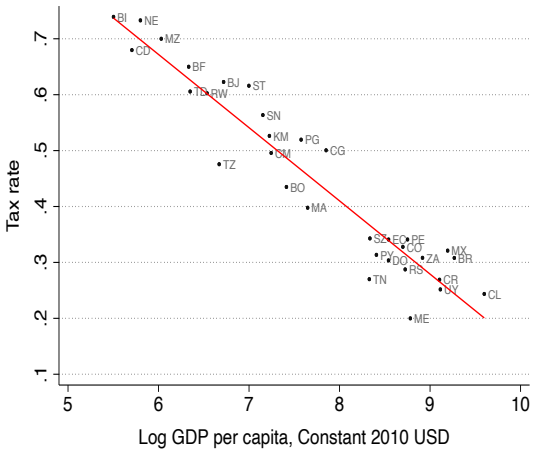
This figure plots the ratio (in log) of the budget shares spent on a good by the richest quintile over that of the poorest quintile, as a function of countries' per capita GDP, as described in Section 5.2. The log transformation implies that a positive value of the budget share ratio corresponds to a progressive tax base, a negative value to a regressive one and a zero value to a neutral tax base (i.e. the budget share of rich and poor are equal). The slopes of the fitted lines correspond to the elasticity of the budget shares of the rich vs the poor as countries grow. Each panel considers a different potential tax base: (a) formal consumption, (b) formal food, (c) formal non-food, (e) food (formal and informal), (f) non-food (formal and informal). Panel (d) shows the linear fits of panels (b) and (c) in orange, and panels (e) and (f) in green, to directly compare the progressivity of taxing different bases. The within color differences, measure the progressivity gains from exempting food, as a function of economic development. The within pattern differences, measure the progressivity gains due to the existence of informal (un-taxable) consumption.

Figure 8: Optimal Uniform Tax Rate on Formal Goods across Countries

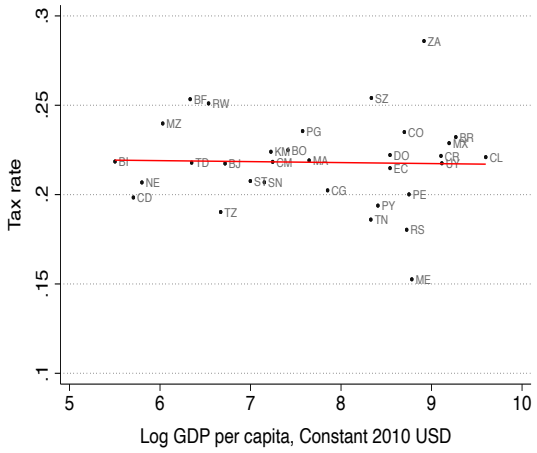
(a) Baseline: Substitution Elasticity = 1.5



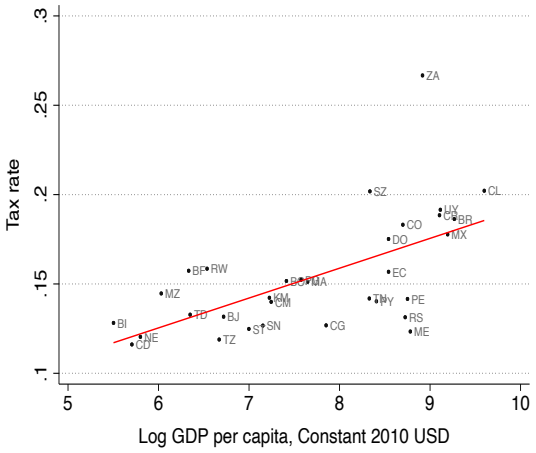
(b) No Efficiency Cost



(c) Substitution Elasticity = 1



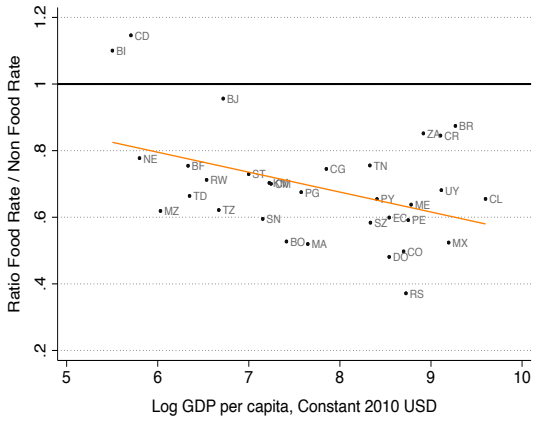
(d) Substitution Elasticity = 2



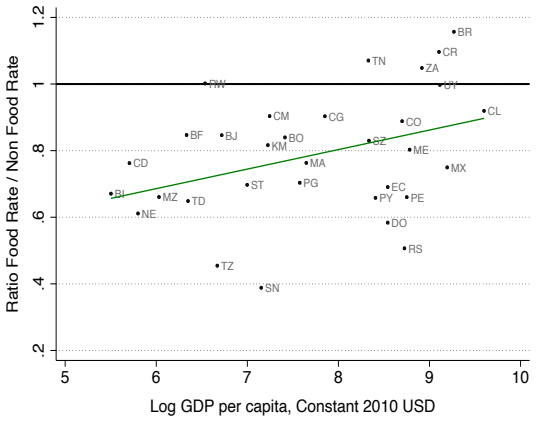
The figures plot the optimal uniform tax rates, calibrated with expression (6) as a function of a country's log GDP per capita, discussed in Section 7.1. We allow price elasticities to vary across goods and countries by calibrating values using expression (4). Panel a shows our baseline results which use a substitution elasticity across formal and informal varieties, ($\tilde{\epsilon}^C$) of 1.5. Panels b c, d vary the efficiency costs by changing the substitution elasticity, to respectively, 0, 1 and 2. The lines correspond to the best linear fits.

Figure 9: Optimal Rate Differentiation Food vs Non-Food across Countries

(a) Formal Goods Taxed



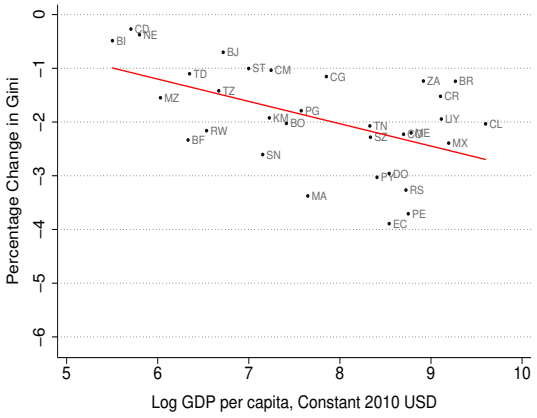
(b) All Goods Taxed (Unrealistic Scenario)



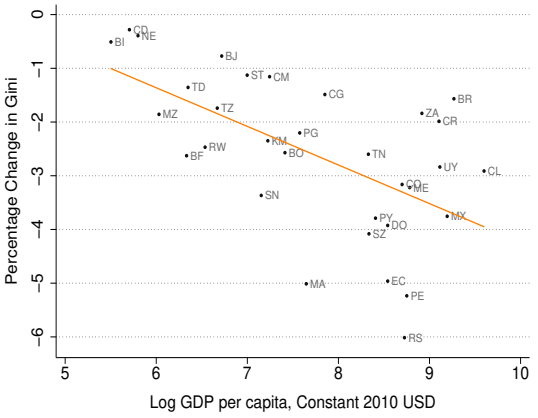
The figures plot the ratio of the calibrated optimal tax rate on food over that on non-food goods, as a function of a country's log GDP per capita, presented in Section 7.1. Optimal rates are calibrated using expressions (9) for panel a and (8) for panel b. The cross-variety elasticity of substitution is fixed at its base value of 1.5. Panel a corresponds to the scenario where only formal varieties are taxed, while panel b corresponds to the unrealistic counterfactual where all varieties can be taxed. A ratio of tax rates of one indicates that the optimal rates of food and non food are equal, and a ratio below one that it is optimal to set a lower rate on food goods. Lines denote best linear fits.

Figure 10: Inequality Reduction from Optimal Tax Policy across Countries

(a) Uniform Rates



(b) Rate Differentiation



The figures plot the percentage change in the Gini coefficient from applying optimal commodity tax rates, accounting for informal consumption, on a country's log GDP per capita, discussed in Section 7.2. The Gini coefficients are measured using percentiles of the pre-tax and post-tax expenditure distributions. Panel a corresponds to the uniform tax rate scenario and panel b to the scenario with differentiated rates for food and non-food goods. Lines denotes the best linear fit.

Table 1: Household Expenditure Surveys

Country	Code	Survey	Year	GDP pc (USD)	# Households	# Items/Hhld
Benin	BJ	EMICOV	2015	828	19871	32
Bolivia	BO	ECH	2004	1658	9149	49
Brazil	BR	POF	2009	10595	56025	41
Burkina Faso	BF	EICVM	2009	563	8404	152
Burundi	BI	ECVM	2014	245	6681	90
Cameroon	CM	ECAM	2014	1400	10303	81
Chad	TD	ECOSIT	2003	572	6697	94
Chile	CL	EPF	2017	14749	15239	129
Colombia	CO	ENIG	2007	5999	42373	60
Comoros	KM	EDMC	2013	1373	3131	82
Congo DRC	CD	E123	2005	301	12098	107
Congo Rep	CG	ECOM	2005	2569	5002	85
Costa Rica	CR	ENIGH	2014	8994	5705	68
Dominican Rep	DO	ENIGH	2007	5121	8363	88
Ecuador	EC	ENIGHUR	2012	5122	39617	89
Eswatini	SZ	HIES	2010	4169	3167	44
Mexico	MX	ENIGH	2014	9839	19479	61
Montenegro	ME	HBS	2009	6516	1223	149
Morocco	MA	ENCDM	2001	2095	14243	90
Mozambique	MZ	IOF	2009	416	10832	221
Niger	NE	ENCBM	2007	330	4000	192
Papua NG	PG	HIES	2010	1949	3810	111
Paraguay	PY	EIGCV	2011	4479	5417	88
Peru	PE	ENAHO	2017	6315	43545	78
Rwanda	RW	EICV	2014	690	14416	54
Sao Tome	ST	IOF	2010	1095	3545	100
Senegal	SN	EDMC	2008	1278	2503	299
Serbia	RS	HBS	2015	6155	6531	105
South Africa	ZA	IES	2011	7455	25328	44
Tanzania	TZ	HBS	2012	788	10186	318
Tunisia	TN	ENBCNV	2010	4142	11281	139
Uruguay	UY	ENIGH	2005	9079	7043	77

This table lists alphabetically the 32 countries in our data the survey names and years, as discussed in Section 2.1. GDP per capita is in PPP USD in the year of the survey, obtained from the World Bank Development Indicators. Code refers to the country acronym which we use in the figures. The sample size refers to the number of households in the survey, and the number of items is the number of expenditure items reported on average per household.

Table 2: Average Slopes of the Informality Engel Curves

Specification:	**Main**		**Geography**		**Product Codes**				**All**
Avg. of 32 Countries	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(Negative of) Slope	10.2	11.0	9.5	8.6	7.2	6.7	6.4	5.9	4.6
Confidence Interval	[9.6,10.8]	[10.3,11.6]	[8.9,10.2]	[7.8,9.3]	[6.6,7.8]	[6.2,7.1]	[5.9,6.9]	[5.4,6.3]	[4.1,5.0]
# of p-values < 0.05	32	32	32	32	32	31	31	31	29
R^2 adjusted	0.20	0.22	0.27	0.43	0.44	0.52	0.52	0.52	0.55
Household Characteristics		X	X	X	X	X	X	X	X
Urban/Rural			X						
Survey Blocks				X					X
Food Products					X				
COICOP 2-dig						X			
COICOP 3-dig							X		
COICOP 4-dig								X	X

This table shows the (negative) average slope of the Informality Engel Curves across countries for different specifications, as discussed in Section 4.2. Column 1, reports the slopes estimated from the following regression: $Share\ Informal_{ip} = \beta_0 + \beta_1 ln(expenditure_i) + \varepsilon_{ip}$ where $Share\ Informal_{ip}$ is the share of household i's informal expenditure on product p. Each observation is weighted using household survey weights and the expenditure share of the product. Average of lower and upper bound of 95% confidence intervals in brackets, from robust standard errors. Column 2 augments this regression with controls for household characteristics (household size, age, gender, education of head). Column 3 (4), adds fixed effects for urban/rural (survey enumeration blocks). Column 5, instead adds fixed effects for food versus non-food products. Columns 6/7/8, instead add fixed effects for product codes at 2nd/3rd/4th level of the COICOP classification. Column 9 adds household characteristics and fixed effects for survey blocks and COICOP-4.

Table 3: Baseline Calibration Parameters

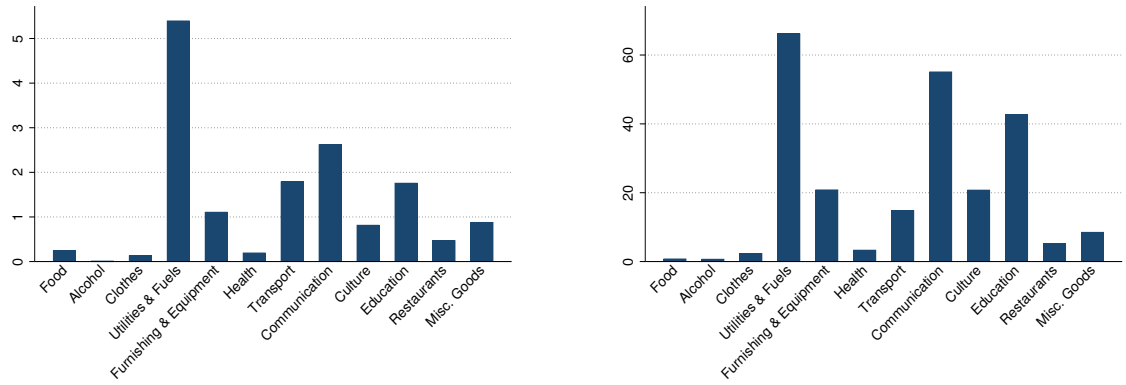
Parameter	Value	Justification
Budget shares s_j^i and s_{j1}^i	Varying	Observed in our data
Household income (scaled) ϕ^i	Varying	Observed in our data
Income elasticities of goods η_j	Food: 0.65, Non-food: 1.2	From our data, using $\eta_j = 1 + \frac{\beta_j}{s_j}$
Income elasticities of formal varieties η_{j1}	Food: 1.14, Non-food: 1.31, All goods: 1.25	From our data, using $\eta_{j1} = 1 + \frac{\beta_{j1}}{s_{j1}}$
Informal share of consumption α_j	Varying	From our data
Cross-variety compensated elasticity $\tilde{\epsilon}^C$	1.5	Faber and Fally (2017); Atkin et al. (2018b)[2]
Own-price compensated elasticity ϵ^C	-0.7	Deaton et al. (1994)[3]
Government preferences g^i	1-10	Average uniform tax rate of 18%[4]

This table presents the parameters used to calibrate optimal commodity tax rates, in Section 7.1.
[1] The parameter β_j (β_{j1}) refers to the estimated slope of the Engel curve for good j (variety $j1$).
[2] For the cross-variety price elasticity we use estimates of the elasticity of substitution σ across store types in consumption obtained by Faber and Fally (2017); Atkin et al. (2018b) which are in the $[2, 4]$ range. With a CES utility function $\tilde{\epsilon}^C = \sigma s_0$ where s_0 is the aggregate budget share spent in the informal sector, equal to 0.5 on average in our sample.
[3] Our choice of value for ϵ^C together with our estimated income elasticities and observed budget shares yield uncompensated own-price elasticities for goods in the $[-2, -0.5]$ range, in line with estimates obtained by Deaton et al. (1994) in the developing country context.
[4] To match the average tax rate of 18% across countries, welfare weights fall for each decile in steps of approximately one. Thus, $g^i \approx 10$ for the first decile, $g^i \approx 9$ for the second decile, $g^i \approx 8$ for the third decile, ..., $g^i = 1$ for the tenth decile. Together with our other calibration choices, this yields an average optimal uniform rate of 18%, with country-specific rates in the 15-20% range, in line with observed consumption tax rates in developing countries.

Online Appendix
"Informality, Consumption Taxes and Redistribution"

A Additional Figures and Tables

Figure A1: Unspecified Places of Purchase by Good

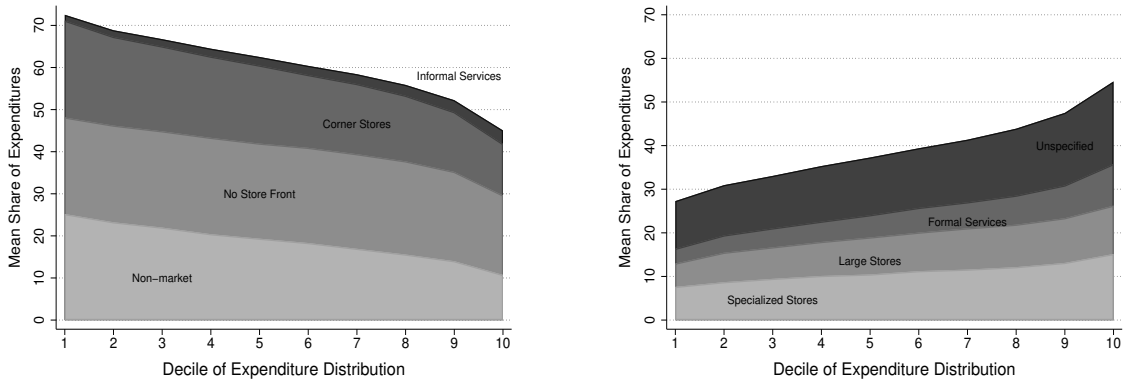


This figure shows the share of expenditures with an unspecified place of purchase by good type (COICOP-2 digit) on average across the 32 countries of the sample, discussed in Section 2.2.

Figure A3: Average Expenditure of Each Decile By Formality Assignment

(a) Informal Places of Purchase

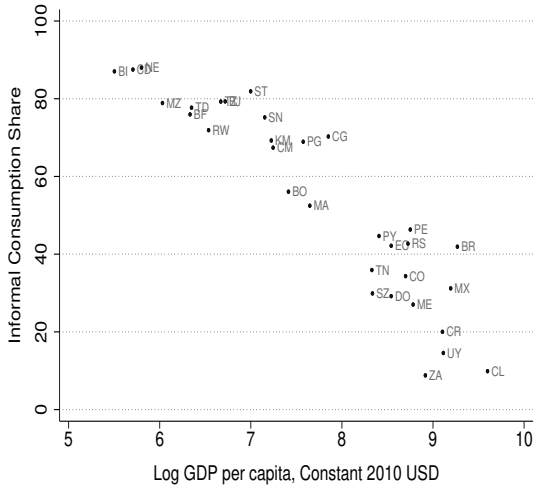
(b) Formal Places of Purchase



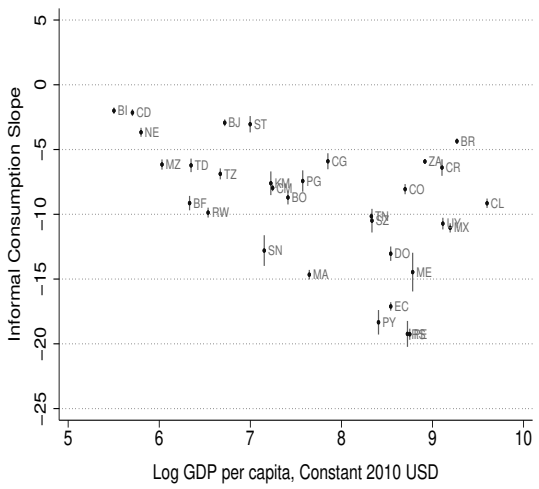
This figure shows the average expenditure of each decile across countries by type of retailer, following the retailer taxonomy described in Section 3.2. Panel (a) shows the places of purchase classified as informal and Panel (b) shows the places of purchase classified as formal in the central scenario of the paper.

Figure A4: Alternative Assignment Scenarios for Informal Expenditure

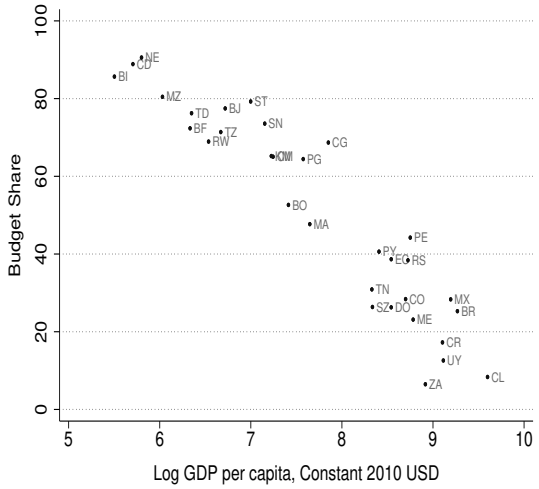
(a) Budget Shares (Country Specific)



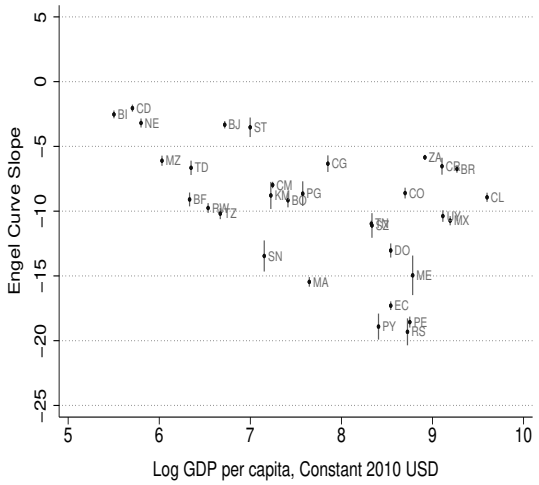
(b) Slopes (Country Specific)



(c) Budget Shares (VAT on Input)

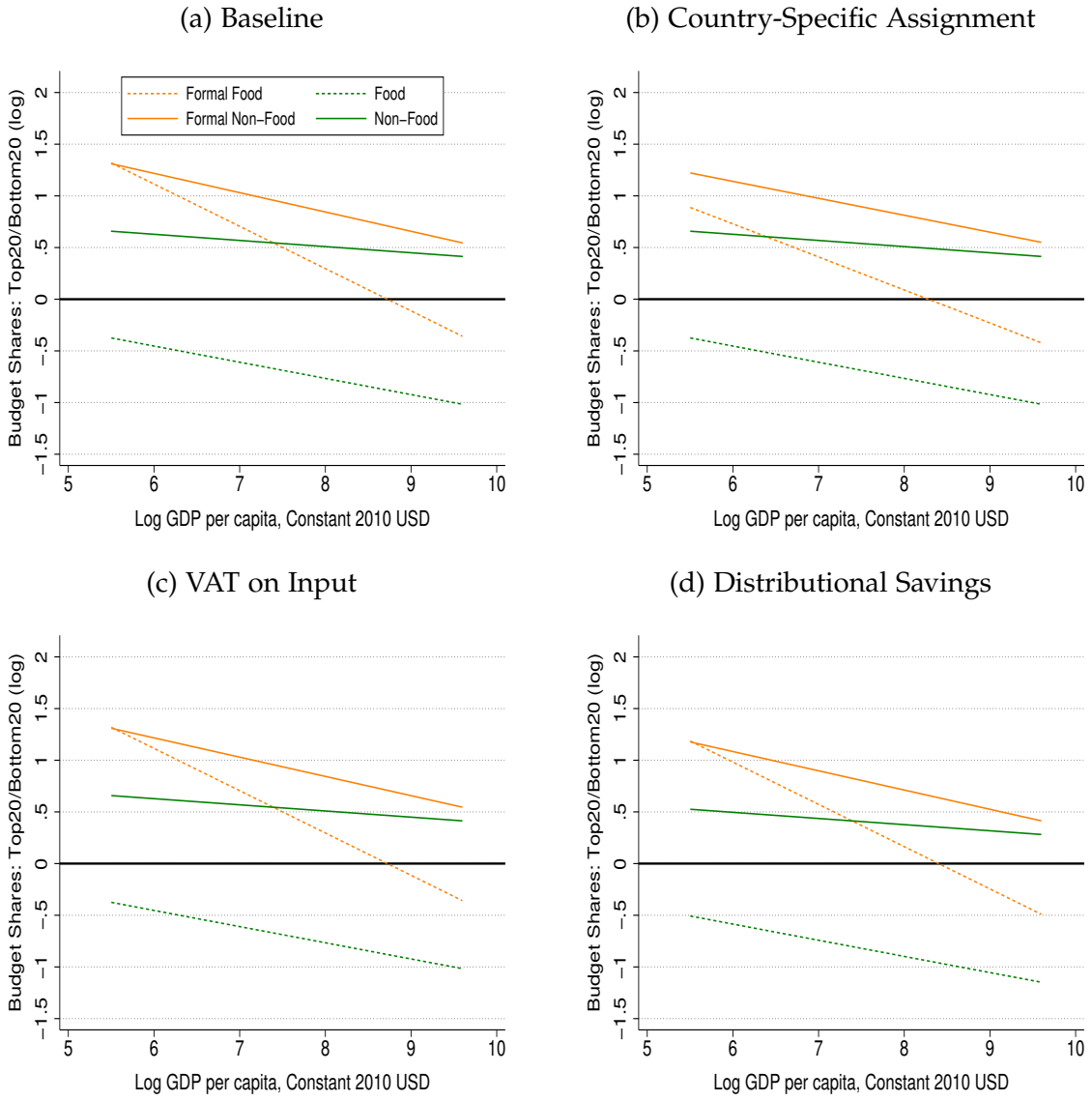


(d) Slopes (VAT on Input)



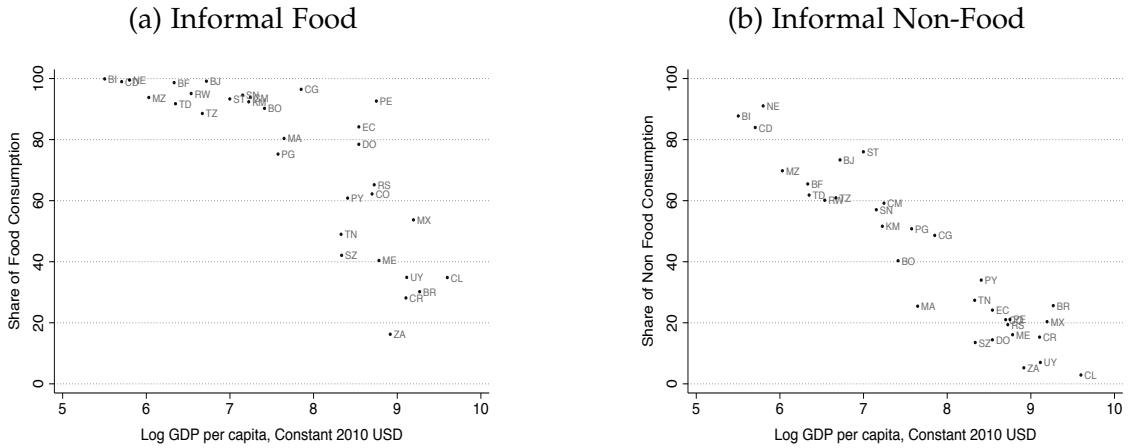
This figure is the equivalent of Figure 4 for the two alternative assignments of store types to formality. It shows informal consumption's aggregate budget shares and Engel curves over countries log GDP per capita. It is discussed in Section 4.1. The country-specific scenario differs from the baseline scenario by assigning a probability of formality to modern and traditional stores based for each country. The VAT on input scenario allows for a 10% pass-through of taxes on informal prices, based on the results found for Mexico. The bars correspond to the 95% confidence interval of the slope coefficient. GDP per capita is in constant 2010 USD (Source: World Bank WDI).

Figure A5: Progressivity of Taxes Bases Over Development in Different Scenarios



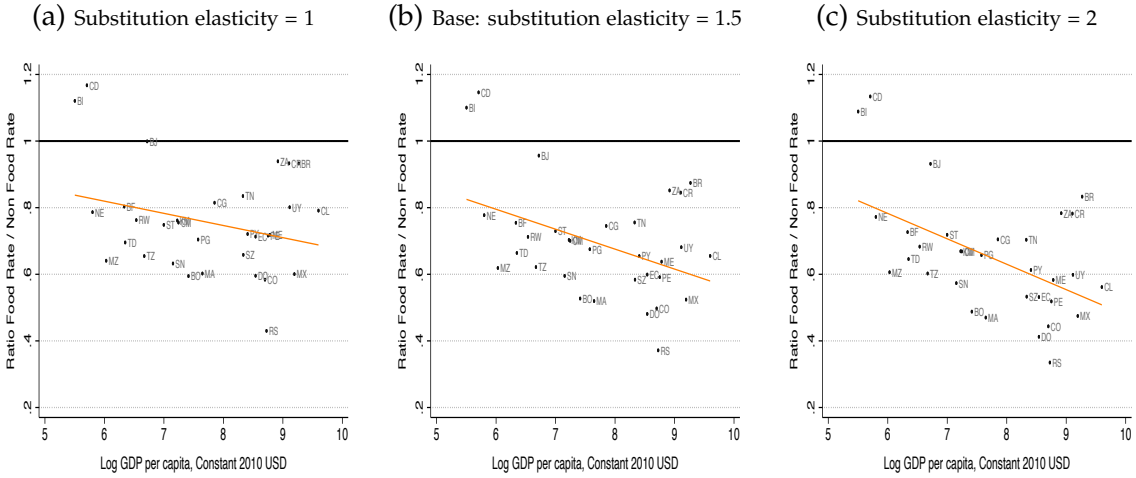
This figure repeats Figure 7d under different assumptions, discussed in Section 5.3. Panel (a) repeats the baseline for comparison. Panel (b) uses the country specific probabilities of formality for modern and traditional stores. Panel (c) Allows for a 10% pass-through of taxes to informal prices. Panel (d) allows for country-specific distributional savings. This vertical axis shows the ratio (in log) of the budget shares spent on a good by the richest quintile over that of the poorest quintile. the horizontal axis is per capita GDP. The log transformation implies that a positive value of the budget share ratio corresponds to a progressive tax base, a negative value to a regressive base and a zero value to a neutral tax base (i.e. budget shares of rich and poor are equal). The slopes of the fitted lines correspond to the elasticity of the budget shares of the rich vs the poor as countries grow.

Figure A6: Informal Consumption as a Share of Good's Consumption



This figure shows informal consumption as a share of good's consumption on log GDP per capita, discussed in Section 6.2. Panel (a) corresponds to informal food, and panel (b) to informal non-food. For each good, this is constructed as informal consumption of the good divided by its total consumption.

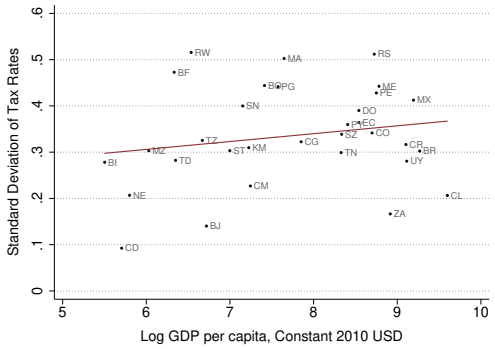
Figure A7: Optimal Rate Differentiation: Varying Elasticity of Substitution



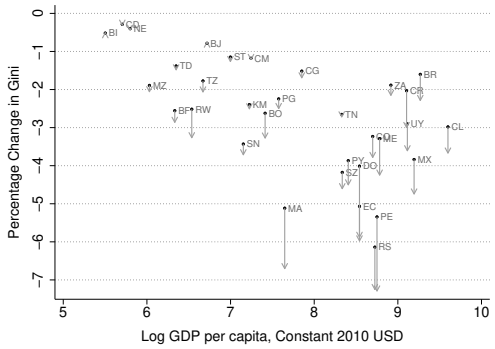
The figures plot the ratio of the calibrated optimal tax rate on food over that of non-food goods, when only formal varieties are taxed, as a function of a country's log GDP per capita. This is discussed in Section 7.1. Optimal rates are calibrated using expression (9). The cross-variety elasticity of substitution varies across panels. A ratio of tax rates of one indicates that the optimal rates of food and non food are equal, and a ratio below one that it is optimal to set a lower rate on food goods. The lines correspond to the best fits.

Figure A8: Tax Rate Differentiation across the Twelve Main Goods

(a) Tax Rates Dispersion



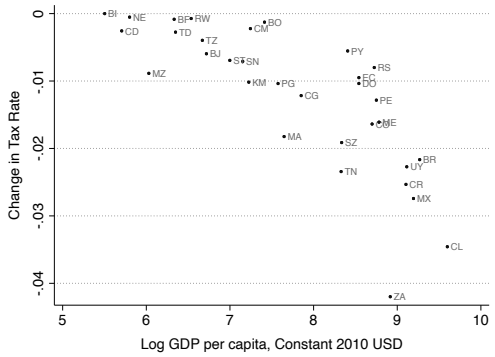
(b) Marginal Impact on Inequality



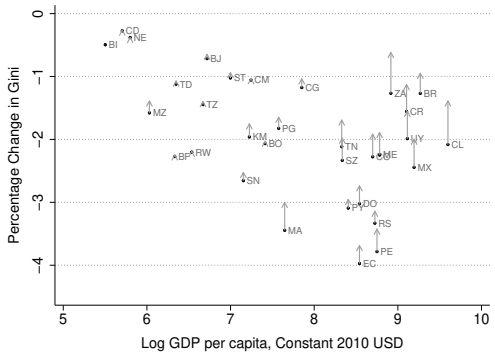
This figure shows the dispersion in optimal tax rates and the inequality reduction achieved by setting optimal rates across the twelve main goods of the UN COICOP classification (two digit level), over development, discussed in Section 7.3. Panel (a) shows the dispersion in tax rates, measures as the normalized standard deviation of tax rates (coefficient of variation) for each country. Panel (b) shows the impact on inequality of further rate differentiation: starting from the Gini reduction achieved when differentiating across food and non-food goods, the arrows show the marginal increase of going to a full rate differentiation.

Figure A9: Impact of Income Taxes on Optimal Uniform Consumption Taxes

(a) Uniform Consumption Rate Change

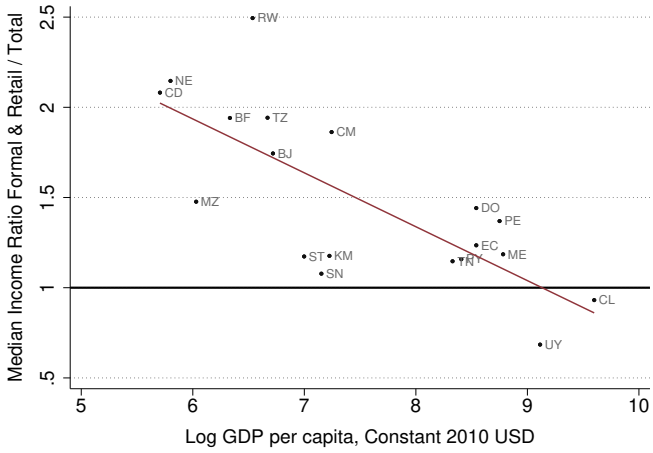


(b) Marginal Impact on Inequality



This figure shows how the presence of an income tax changes optimal uniform consumption tax rates, and the redistribution they can achieve, as a function of countries' log GDP, discussed in Section 7.3. The baseline are the uniform rates and inequality reduction achieved by consumption taxes without an income tax. Panel (a) shows how uniform consumption tax rates change with an income tax. Panel (b) shows the marginal impact on inequality reduction from consumption taxes, of the personal income tax.

Figure A10: Income of Formal Retail Workers Relative to the Median



This figure plots the ratio of the median income of formal retail workers over that of all workers, as a function of countries' per capita GDP, described in section 7.4. Employment is considered formal if the worker contributes to health or pension funds. We conduct this analysis in 19 countries of our sample, where information on labor formality is available, using the employment status households' heads. Total expenditures proxies for income.

Table A1: Main Reason for Choosing this Place of Purchase

	Outcome: Share of purchases (in %)		
Reason	**Informal Stores**	**Formal Stores**	**All Stores**
Access	42.1	31.3	41.5
Price	29.4	17.7	28.6
Quality	11.8	40.6	13.4
Store Attributes	6.9	5.0	6.9
Other	9.8	5.5	9.6

The table reports for each potential reason households report for using a particular place of purchase, the share of purchases associated with this reason, as discussed in Section 4.2. Each number is an average across the six countries in our core sample in which the household survey asks this questions. These countries are Benin, Burundi, Comoros, Congo Rep., Morocco and RD Congo. In all surveys seven reasons are listed which we classify into five categories as follows: access is defined as "The retailer is closer or more convenient" and "The good or service cannot be found elsewhere", price as "The good or services are cheaper", quality as "The goods or services are of better quality", store attributes as "The retailer offers credit" and "The retailer is welcoming or is a friend" and other as "Others reasons".

Table A2: Unit Values Across Places of Purchase

	Outcome: % dif. in formal sector unit values				# Purchases	# FE
Country	(1)	(2)	(3)	(4)	(5)	(6)
Benin	5.25	1.10	3.38	-0.39	262,280	5,065
	(7.10)	(5.66)	(7.53)	(6.19)		
Bolivia	4.08	3.53	4.69	3.86	120,971	1,549
	(1.40)	(1.12)	(1.40)	(1.15)		
Brazil	-0.11	-0.20	0.14	0.01	704,639	9,437
	(0.37)	(0.35)	(0.38)	(0.35)		
Burundi	2.53	4.39	4.81	5.23	250,139	2,454
	(4.65)	(4.73)	(4.39)	(4.23)		
Chad	-4.36	-3.21	-4.36	-3.21	380,462	1,968
	(1.80)	(1.77)	(1.80)	(1.77)		
Colombia	-0.33	-0.04	-0.30	-0.06	778,203	7,861
	(0.55)	(0.30)	(0.55)	(0.30)		
Comoros	22.56	14.93	21.81	14.49	113,228	1,142
	(5.01)	(3.64)	(4.98)	(3.64)		
CongoDRC	4.62	0.87	9.77	5.89	865,754	5,556
	(16.79)	(12.88)	(17.47)	(14.15)		
Congo Rep	27.84	23.70	27.12	23.01	208,557	1,182
	(5.88)	(4.67)	(6.03)	(4.78)		
Costa Rica	3.04	2.37	1.93	1.58	122,467	1,593
	(2.40)	(2.11)	(2.17)	(1.93)		
Dominican Rep	18.86	13.64	18.94	13.73	340,303	4,416
	(1.69)	(1.01)	(1.68)	(1.00)		
Ecuador	2.29	1.86	2.23	1.82	1,030,387	12,104
	(0.63)	(0.63)	(0.63)	(0.62)		
Eswatini	3.09	2.38	1.31	1.06	89,209	852
	(2.10)	(1.79)	(1.89)	(1.46)		
Mexico	1.10	1.00	1.10	1.00	446,417	6,195
	(1.16)	(1.02)	(1.16)	(1.02)		
Montenegro	10.36	9.57	7.13	6.45	138,446	867
	(3.70)	(3.25)	(3.08)	(2.85)		
Morocco	7.10	5.43	6.88	5.22	743,979	3,598
	(0.87)	(0.70)	(0.92)	(0.75)		
Peru	14.70	13.29	14.69	13.29	1,300,408	10,721
	(2.74)	(2.46)	(2.74)	(2.46)		
Sao Tome	6.81	4.87	6.69	4.86	215,527	2,946
	(1.39)	(1.37)	(1.39)	(1.34)		
Serbia	2.39	2.03	2.86	2.49	503,344	9,332
	(0.49)	(0.46)	(0.51)	(0.48)		
Tanzania	2.11	1.59	2.80	2.21	1,169,193	13,771
	(0.73)	(0.68)	(0.59)	(0.55)		
Avg. of 20 Countries	6.70	5.16	6.68	5.13		
Confidence Interval	[0.7,12.7]	[0.2,10.1]	[0.7,12.7]	[0.1,10.1]		
# of p-values < 0.05	12	12	11	11		
Winsorization [5,95]		X		X		
Self Consumption			X	X		

This table shows the percent difference in unit values in the formal compared to the informal sector. The sample is restricted to food purchases, for which units and unit values are detailed, in the 20 core sample countries with such data. This is discussed in Section 4.2. Formally it runs the following specification: $ln(unit\ value)_{ipmu} = \beta\ Formal_{ipmu} + \mu_{pmu} + \epsilon_{ipmu}$, where $ln(unit\ value)_{ipmu}$ is the unit value reported by household i, for product p, in location m, in units u, and $Formal_{ipmu}$ equals one if the product is purchased in a formal store. We add fixed effects at the product*location* unit of measurement. Standard errors are clustered at the location level.

Table A3: Ratio Top over Bottom Quintile of Effective Tax Rates

Tax policy	Baseline Assignment	Country-Specific Assignment	Baseline + VAT on Input	Baseline + Distributional Savings
Uniform rate, only formal taxed	2.03	1.77	1.60	1.94
Food exempt, only formal taxed	2.28	2.14	2.11	2.17
Food exempt, formal and informal taxed	1.64	1.64	1.64	1.56

This table shows the progressivity of consumption tax policies, measured as the effective tax rate paid by the richest household quintile over that of the poorest quintile, discussed in Section 5.3. The numbers are averages for the 32 countries. The rows correspond to the three tax policy scenarios considered: (1) a uniform tax rate on all goods when only formal goods are taxed, (2) a zero rate on food, when only formal goods are taxed, (3) a zero rate on food, in the naive scenario where both formal and informal goods are taxed. Column (1) corresponds to the baseline informality assignment (modern retailers are formal and traditional retailers are informal). Column (2) assigns country-specific probabilities of formality to modern and traditional stores. Column (3) assumes a 10% pass-through of taxes to the informal sector. Column (4) adds country-specific distributional savings rates.

Table A4: Change in Gini from Optimal Tax Policy

Tax policy	(1) Baseline Assignment	(2) Cross-variety Elasticity	(3)	(4) Country-Specific Assignment	(5) Baseline + VAT on Input	(6) Baseline + Distributional Savings
Panel A: Average across countries		$\tilde{\epsilon}^C = 1$	$\tilde{\epsilon}^C = 2$			
Uniform rate	-1.95	-2.39	-1.66	-1.77	-1.75	-1.87
Food rate differentiation	-2.65	-3.12	-2.32	-2.40	-2.53	-2.54
Full rate differentiation (12 goods)	-3.20	-3.56	-2.84	-2.86	-2.99	-3.00
Uniform rate with PIT	-1.72	-2.12	-1.46	-1.57	-1.53	-1.65
Food rate differentiation with PIT	-2.33	-2.75	-2.03	-2.11	-2.21	-2.23
Panel B: Middle/Lower Income Countries Ratio						
Uniform rate	1.55	1.39	1.67	1.54	1.62	1.52
Food rate differentiation	1.80	1.58	1.99	1.82	1.81	1.76
Full rate differentiation (12 goods)	1.93	1.70	2.11	1.94	1.93	1.87
Uniform rate with PIT	1.40	1.25	1.51	1.40	1.45	1.38
Food rate differentiation with PIT	1.64	1.43	1.81	1.66	1.64	1.61

This table shows the redistributive impact of different consumption tax policies under different hypothesis, as presented in section 7.2. Our metric for redistribution is the percent change in Gini from the pre-tax income distribution to the net-of-tax distribution. We take the average across the 32 countries in the sample. The rows correspond to the tax policy scenarios considered. (1) uniform rate on all goods (2) optimal differentiated tax rates on food and non food goods (3) optimal differentiated tax rates for each of the 12 large goods categories (COICOP 2 digit) (4) uniform rate on all goods and a personal income tax (5) optimal differentiated tax rates on food and non food goods and a personal income tax. The columns correspond to the different assumptions we make about the data. The baseline in column (1) corresponds to the central assignment of modern retailers to VAT-formality, and to a value of the cross-variety elasticity of substitution of 1.5. columns (2) and (3) vary the elasticity of substitution. Column (4) assigns the country-specific probabilities of formality status to modern and traditional stores. Column (5) assumes a 10% pass-through of taxes to the informal sector. Finally column (6) adds country-specific distributional savings rates.

B Appendix: Data on Consumption

All codes to replicate the paper are available at https://github.com/pierrebachas/Informality_Taxes_Redistribution. This includes cleaning files for each country's micro data, and all files generating tables and figures in the paper.

Inclusion Criteria Our dataset consists of 32 nationally representative household budget surveys. We use surveys which satisfy the following three criteria:

1. The expenditure module(s) in the survey is structured as an open consumption diary, rather than a pre-filled diary covering a limited set of products.
2. The expenditure survey includes a variable for the place of purchase (data on where each item was purchased). The place of purchases are detailed enough for us to apply our taxonomy of store types, as outlined below.
3. The place of purchase variable rarely contains missing values, particularly for food, clothing and household goods product categories (see Figure A1).

Data Sources and Coverage Most of our data come from two main sources: (i) the World Bank Microdata Library and (ii) National Statistical Agencies. To access the data we searched the restricted access World Bank Microdata Library for household expenditure surveys for which the above criteria appeared to be satisfied. The surveys which satisfied these criteria varied in their ease of access: for some countries, the micro data were accessible for download on the World Bank platform, others were licensed and required applications through the World Bank, which would in turn sometimes contact the country's national statistical agency for approval. If a survey was listed without its micro data through the World Bank platform, we reached directly the country's' statistical agency.

The countries which satisfied the criteria for inclusion span four regions of the world, concentrated in Sub-Saharan Africa and Latin America and the Caribbean, as detailed in Table B1. Unfortunately we could not include countries in Asia—except for Papua New-Guinea—since the question on the place of purchase was always missing from their budget surveys. The online appendix lists the 32 countries which we include, with summary statistics on the structure of each survey. Any slight deviation from our inclusion criteria is outlined.

Table B1: Regional Survey Representation

Region	# Countries	Pop. of Surveyed Countries (Millions)	Total Pop. (Millions)	Proportion of pop.
Sub-Saharan Africa	16	379	1078	35%
Middle East & North Africa	2	48	449	11%
Europe & Central Asia	2	9	918	1%
Latin America & Carribean	11	496	641	77%
East Asia & Pacific	1	9	2328	0.4%

Consumption Module Structure Surveys are not homogeneous across countries. We provide a summary below (country by country information in the online appendix):

- **Number and frequency of modules:** the number of consumption modules ranges from 1 to 17 across countries in the sample. All surveys have a module which is a diary of consumption over some short to medium period of time and some countries complement these with recall modules for more infrequent purchases. For example, Costa Rica has a single consumption module, while Morocco has 17, with modules specialized by frequency and products. Surveys with multiple modules typically asked for consumption linked to the frequency of expenditures (e.g. monthly, quarterly).

- **Durables:** durable items are included whenever available, but their inclusion is more probable in surveys which have recall modules.

- **Home-production:** home production is included as a "place of purchase" for all countries but Chile where it is not available. In some countries, it was precoded as an option for the place of purchase, while in other cases we added it as a place of purchase based on other variables, such as "acquisition mode" which had "purchased or "self/home production." Self-production purchases are typically valued using the local market value.

- **Product codes:** all surveys have product codes for each consumption item, which typically follow the United Nations Classification (COICOP) or which we can match to the COICOP with a cross-walk. For a few countries we could not find a product crosswalk. We used each country's own classification scheme' for these four countries (Brazil, Chad, Peru and Tunisia).

Categories of Places of Purchase Each of the 32 countries have a place of purchase for each transaction. The different place of purchases options available to respondents however differ across countries. However, these can be classified into broad categories which are roughly equivalent across countries. To the best of our knowledge, the only other project which constructs a common taxonomy of places of purchases across countries is the International Price Comparison (ICP) project, which builds purchasing power parity indexes. The ICP provides a store type classifier for marketed consumption which is used by individual countries to obtain price quotes from a variety of retailer types. Our classification mirrors that of the ICP. Consumption of goods is categorized into five broad categories of places of purchase: (1) non-market consumption (e.g. home-production); (2) Market consumption, no store front (e.g. markets, street stalls); (3) Market consumption, corner and convenience shops; (4) Market consumption, specialized shops (e.g. brand stores); (5) Market consumption, large stores (e.g. supermarkets, malls). Consumption of services is categorized into four categories: (6) Services provided by institutions (e.g. bank, hospital, university); (7) Service provided by individuals (e.g. maid services, gardening); (8) Entertainment (e.g. restaurants, hotels); (9) Informal Entertainment (e.g. food truck).

The majority of countries have places of purchase for each of the five good categories. Four countries do not distinguish between specialized stores (category 4) and corner/convenience stores (category 3). For these countries, we use the following methodology: i) for each decile we compute the budget share of categories 3 and 4 together using the survey. ii) for each decile we compute the average share of category 3 in the total budget share of categories 3 and 4 in comparable countries, where we define 'comparable' as countries whose average GDP per capita is in the 50-150% range of the country's GDP per capita. iii) We then impute the relative shares of categories 3 and 4 in the country using these average relative shares at the decile level.

In some countries all services do not have a specified place of purchase. In particular there is no detailed list of institutions as potential places of purchases. These are also countries in which the share of expenditures with an 'unspecified' place of purchase is larger: indeed when looking at what types of products compose the unspecified category, over half are utilities, while the remaining is mainly education and health spending. Finally, we assign the remaining places

of purchase that are harder to categorize (e.g. purchases from internet or from abroad) to category (6) "services provided by institutions". We note that these represent less than 0.5% of total expenditure.

For replication purpose the countries-specific assignment of specific places of purchase to the broad categories presented above is detailed in the online appendix, where each place of purchase representing more than 0.5% of total expenditure is included with its original name in the survey.

C Appendix: Formality Assignment of Store Types

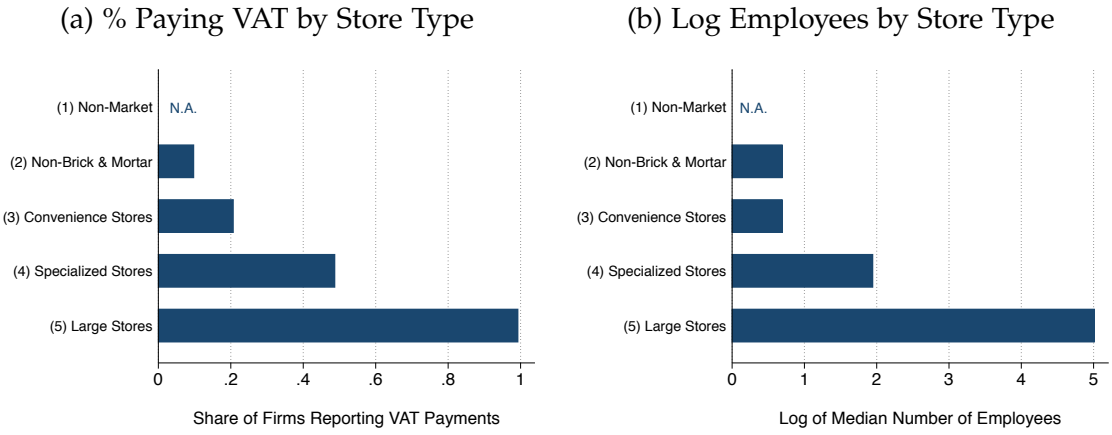
C.1 Evidence on Sales Formality Status by Store-Type

Mexico's Firm Census The 2013 Mexican firm census details store-type classification for the universe of modern and traditional retailers in the country – with the caveat that home-based vendors and makeshift stalls that change location frequently are excluded. The absence of data on these store-types likely leads us to overestimate the sales formality status among all traditional retailers. The census also asks firms for their remittance of VAT on their sales and on their inputs. We define a store to be VAT formal if it levies VAT on any of its sold products. This data allows us to directly observe VAT status by detailed store-type. Figure C1 Panel (a) shows that the share of traditional retailers (non-brick and mortar; convenience stores) remitting VAT is 10%. This contrasts with modern stores, where the VAT-share is between 51% (in specialized stores) and 98% (in large stores such as supermarkets). Traditional and modern retail stores therefore differ substantially in the extent of VAT sales formality. This is likely driven in part by the large size difference between these two types of stores: C1 Panel (b) shows a large difference in the median number of employees. This increases the likelihood that traditional retailers are legally exempt from VAT and constrains enforceability.

Cross-country Evidence: Data and Methodology How does the sales formality status of traditional retailers in Mexico compare to other countries at different income levels? We combine two datasets used in the literature, described below.

The first source is the World Bank firm surveys: the Enterprise Surveys (ES) and the Informal Surveys (IS). 35 low and middle income countries have both of these survey types (from Africa, Asia and Latin America). These surveys contain

Figure C1: Formality by Store Type in Mexico



For construction of these graphs, see Section C.1.

harmonized information for firms in the retail sector on registration status with central government agencies, which we use as the measure of formality.[30] The Enterprise Survey samples firms from geographical areas which are likely to contain a high number of formal firms with more than 5 employees. The Informal Survey samples from areas which are likely to have a high concentration of small and informal firms. Once these sampling zones are established, all firms located in the zone, both registered and unregistered, are considered for the final sample. We refer to La Porta and Shleifer (2014) for a detailed discussion of the sampling methodology and formality definition. Combined, the ES-IS sampling frames provide data-coverage of firms in the traditional and modern retail segment.[31]

The second source are the retail market reports produced by Euromonitor International, which are described in Section 2. These reports contain detailed information on sales and number of units by harmonized store type categories of modern and traditional grocery retail, which we will consider as the retail sample. Bronnenberg and Ellickson (2015) use these in their review of global retail patterns. The modern and traditional store types are consistent with our classification, with the exception that home production is not included in the

[30] For most surveys, registration refers to the central tax administration (in charge of the VAT). We include the remaining surveys to retain as broad a sample as possible; other agencies that firms can be registered with include the chamber of commerce and the national statistics office.

[31] The main exception is that IS cover only incompletely the smallest retailers, including home producers and 'street hawkers', leading us to overstate the formal share in all traditional stores.

Euromonitor reports, while we assign it to traditional stores.

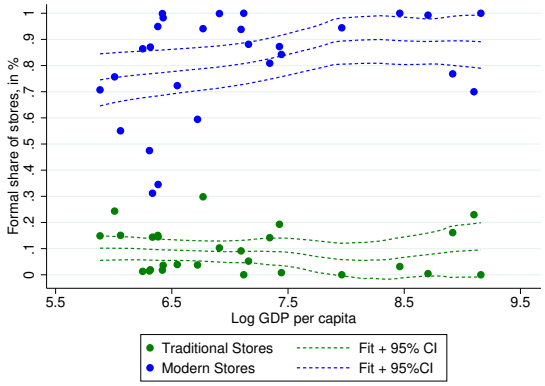
Based on the WB survey data, we can measure the formality probability for retail firms as a function of sales, but not by store type. Based on the Euromonitor data, we can measure average sales by store type (modern or traditional), but not by formality status. We combine these two data sources to obtain a plausible estimate of the average formal share of traditional and modern retailers. To increase the usefulness of combining sales information from different data, we use Euromonitor sales from the same year as the surveys. We also create weights which ensure that the WB based sales distribution is representative of the universe of retailers captured in the Euromonitor data. Despite this, concerns remain about the extent of direct comparability of the retail sales values between ES-IS and Euromonitor. Therefore, our preferred approach is to calculate the ratios of traditional and modern store sales to average retail sales from Euromonitor, and use these ratios to impute the average traditional and modern store values in the ES-IS sample. We define the traditional (modern) formal share as the formality share at which the formality distribution by size intersects the average traditional (modern) size. Ideally, we would superpose a density size distribution and calculate the store type formality share by integration. Unfortunately, the Euromonitor data only allows us to measure averages by store-type.

Cross-Country Results The modern and traditional formality shares are plotted against log GDP per capita for the 33 ES-IS countries in Figure C2, panel (a). Two results emerge: first, the average formal share is 5-15 percent in traditional stores and 75-90 percent in modern stores. These shares are comparable to those obtained in Mexico using retail Census data. Second, the average formality share of traditional stores is stable across countries, and that of modern stores only slightly increases with development.

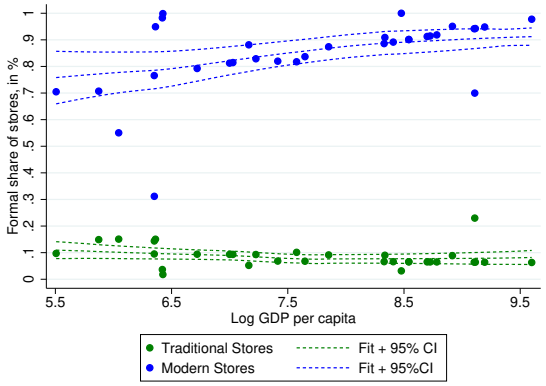
We use the constructed variables to create a data driven, country-specific formality assignment to modern and traditional stores (panel (b) Figure C2). In the 11 countries where we have ES-IS data and expenditure surveys, we directly use the measured values. For the remaining 21 countries in our database, we use the predicted formality shares based on a regression of the modern (traditional) formality share against log GDP per capita and continent dummies. Even though the sample size is small, the relative stability of formality shares across log GDP

Figure C2: Formality by Store Type Across Development

(a) Formality Share by Store Type



(b) Formality Share in our Sample



For construction of these graphs, see Section C.1.

per capita and continent suggests that this exercise yields meaningful predictions.

Relation to VAT exemption thresholds We record the sales value of the VAT exemption threshold for all countries in our data. Data on VAT thresholds comes from the harmonized set of country tax code reports produced by the International Bureau of Fiscal Documentation. We follow the methodology described in Keen and Mintz (2004). In most countries outside Latin America, the value of the exemption threshold is explicitly defined. In many Latin American countries, the threshold value is the level of sales below which firms are registered for a simplified tax regime rather than VAT. The average size of traditional and modern retail stores, along with value of the VAT exemption threshold, are reported in the online appendix. We find that the ratio of sales-values to the VAT exemption threshold is 1.01 for traditional stores and 38.85 for modern stores.

C.2 Theory: Pass-Through with Monopolistic Competition and Suppliers

In this subsection, we show that our assumptions regarding the pass-through of taxes to prices in the formal and informal sector can be modelled as equilibrium responses of firms in a simple supply side model. Each variety $j1$ is produced by a firm that pays taxes (formal firm), and each variety $j0$ by a firm that does not pay taxes (informal firm). This assigns firms to a formality status based on

whether taxes are levied on sales. We assume that the tax takes the form of a VAT.

Upstream firms k use only labor $x_k = L_k$. Downstream firms produce varieties jl using inputs produced by upstream firms and have the production function:

$$x_{jl} = \Big(\sum_k \alpha_{jlk} x_{jlk}^{\frac{\rho-1}{\rho}} \Big)^{\frac{\rho}{\rho-1}} \tag{10}$$

where x_{jlk} is the quantity of inputs k used by the downstream firm producing variety jl, and ρ the constant elasticity of substitution in production. Labor is paid a fixed wage w. The value of sales for the downstream firms is given by $q_{jl}x_{jl}$ where q_{jl} are the endogenous producer prices, which then determine consumer prices: $p_{j1} = q_{j1}(1 + t_j)$ if the firm is formal, $p_{j0} = q_{j0}$ if the firm is informal. We assume firms compete under monopolistic competition, which implies they maximize profit π_{jl} whilst accounting for the demand function $x_{jl}(p_{jl})$ they face. Writing ϵ_{jl} the price elasticity of demand for variety jl and taking first-order condition with respect to prices, we obtain the expression for consumer prices:

$$p_{jl} = (1 + t_j f_{jl}) \frac{P_{jl}}{\phi_{jl}} \frac{\epsilon_{jl}}{\epsilon_{jl} - 1} \tag{11}$$

where $f_{jl} = 1$ if the firm producing jl is formal, zero otherwise, and P_{jl} is its input cost index. P_{jl} is obtained by cost minimization and equal to:

$$P_{jl} = \Big(\sum_k \alpha_{jlk}^{\rho} p_{jlk}^{1-\rho} \Big)^{1/(1-\rho)} \tag{12}$$

Here p_{jlk} is equal to the net of tax price paid for the product k by the firm producing variety jl. We assume, under a VAT, that: no tax is paid if both firms k and jl are informal; no tax is paid if firm k is informal; tax is paid on the transaction only if upstream firm k is formal and firm jl is informal. Formally:

$$p_{jlk} = (1 + t_k f_k (1 - f_{jl})) w \frac{\rho}{\rho - 1} \tag{13}$$

Combining expressions (11), (12) and (13), we can write the pass-through of taxes to the price of formal and informal downstream firms. The pass-through of

taxes to the price of formal downstream firms ($f_{jl} = 1$) is equal to 1:

$$\frac{\partial p_{j1}}{\partial t_j} \frac{1 + t_j}{p_{j1}} = 1 \tag{14}$$

The pass-through of taxes to the price of informal downstream firms ($f_{jl} = 0$) can be written as:

$$\frac{\partial p_{j0}}{\partial t_j} \frac{1 + t_j}{p_{j0}} = s_{j0F} \tag{15}$$

where s_{j0F} is the share of formal inputs in firm $j0$'s total production costs:

$$s_{j0F} = \sum_k f_k \alpha_{j0k}^{\rho} P_{j0}^{\rho-1} p_{j0k}^{1-\rho} \tag{16}$$

The model shows that the pass-through of a tax rate increase via formal suppliers to informal retailers will be equal to the formal input share in total costs. In the following sub-section, we measure this input-share in Mexican data, and test the model prediction using a VAT rate reform.

C.3 Evidence on Suppliers to Informal Retailers in Mexico

Inputs of Mexican Informal Retailers The Mexican Census allows us to measure the importance of formal VAT suppliers for input sourcing of informal traditional retailers. In the data, among informal retailers, only 8% report paying VAT on inputs, which applies on average to 40% of their intermediate purchases. The informal retailers that report positive VAT on inputs account for 25% of all informal sales. Combined, these data yield an overall formal input cost-share of 10% for informal retailers in the Mexican Census. Note that home producers are not included in the retail Census, but are an important category of informal retailers in our store-type classification. Home producers are plausibly less likely to source inputs from formal suppliers than the traditional retailers captured in the retail Census; for this reason, the Census based estimate of formal input-share might be an upper bound for the input share of all informal retailers.

Beyond this Mexican data, there does not exists, to the best of our knowledge, systematic data across countries which measures the importance of formal suppliers for informal retailers. In 2012, the Informal Economy Monitoring Studies (IEMS) conducted surveys with informal retailers in Ghana, India, Kenya, Peru,

South Africa, and Thailand. The (unweighted) share of respondents that identify formal enterprises as a main supplier was 18.95% in the IEMS, but the data does not permit us to calculate their actual formal input share.

Evidence from 2014 VAT reform Finally, we exploit a 2014 reform in Mexico to estimate the pass-through among informal retailers and test the model prediction that it should equal to formal input-share (equation 15 in Section C.2). We rely on the monthly microdata collected by the national statistics office, INEGI, to construct the measure of consumer price index (CPI) in Mexico. INEGI enumerators obtain price quotes for approximately 83,500 items that cover 315 product categories in 141 municipalities. The price sampling is meant to be representative of Mexican household consumption and contains, importantly for our purposes, price quotes from both modern and traditional retail stores (including street stalls and other non-brick and mortar stores).

We obtain access to the confidential data-set of the Mexican CPI, which allows us to observe the municipality location as well as uniquely identifying information on the store at which the price quote was collected. We merge this data with the 2013 Mexican census at the unique store level, in order to obtain detailed information on the tax status of the store. This allows us to construct measures of product level prices on a monthly basis in both informal and formal retail stores, based on the VAT remittance status discussed previously. We focus on the 127 products which constitute the core inflation items and which are subject to VAT. The estimation sample consists of 409,864 product-location-month price observations in informal retailers between January 2012 and December 2015. The pass-through results remain unchanged if we instead estimate it for traditional retailers (using the store-type classification from the CPI). This is due to the strong overlap between informal status and traditional store-type (C1).

We leverage the variation in VAT rate induced under a reform passed by the Mexican government in January 2014. Prior to the reform, border areas benefited from a VAT reduction, such that the VAT rate was 11% rather than the standard, non-border 16%. The reform increased the VAT rate in the border areas with immediate effect from 11% to 16%, while keeping rates unchanged in the non-border areas. The reform was motivated by the government's long-term objective to equalize tax incentives across the country.

We use a difference-in-differences (DD) design to estimate the VAT rate increase pass-through to consumer prices in informal stores. The DD is described in Section 3.3, along with the main results, and the DD coefficients are in Figure 2. The main results are based on a sample without restrictions, but are robust to excluding observations from Mexico City; restricting control non-border areas to be geographically close to border areas with price data; and, winsorizing the top and bottom 1% of price observations (results available upon request).

D Appendix: Theory And Calibration

D.1 Proof of Propositions

Detailing expression (4) Under our assumption that $p_{j1} \approx p_{j0}, \forall j$ we can write the uncompensated elasticity of product j as a function of the uncompensated elasticities of varieties $j1$ and $j0$ and the cross-variety price elasticities:

$$\epsilon_j = \epsilon_{j1}(1-\alpha_j) + \epsilon_{j0}\alpha_j + \epsilon_{j1,0}(1-\alpha_j) + \epsilon_{j0,1}\alpha_j \tag{17}$$

where $\alpha_j = \frac{p_0 x_0}{px}$ is the share of informal consumption in total consumption of the product and $\epsilon_{j0,1}$ it the elasticity of demand for the informal variety with respect to the price of the formal variety.

Writing ϵ_j^C the compensated price elasticity of product j the Slutsky equation is $\epsilon_j = \epsilon_j^C - \eta_j s_j$. Using this and $\eta_j = \eta_{j1}(1-\alpha_j) + \eta_{j0}\alpha_j$ and $s_j = s_{j1} + s_{j0}$:

$$\epsilon_j^C = \epsilon_{j1}^C(1-\alpha_j) + \epsilon_{j0}^C\alpha_j + \epsilon_{j1,0}^C(1-\alpha_j) + \epsilon_{j0,1}^C\alpha_j \tag{18}$$

Slutsky symmetry implies $\epsilon_{j1,0}^C(1-\alpha_j) = \epsilon_{j0,1}^C\alpha_j$. Using our assumptions of $\epsilon_{j0,1}^C = \tilde{\epsilon}^C, \forall j$, equal compensated own-price elasticity across varieties within products ($\epsilon_{j1}^C = \epsilon_{j0}^C, \forall j$) and equal compensated own-price elasticities across products ($\epsilon_j^C = \epsilon^C, \forall j$), and re-arranging, we obtain:

$$\epsilon_{j1}^C = \epsilon^C - 2\tilde{\epsilon}^C\alpha_j \tag{19}$$

To obtain an expression for the compensated price elasticity ϵ_{j1}, the parameter of interest, we use the Slutsky equation again and obtain:

$$\epsilon_{j1} = \epsilon^C - 2\tilde{\epsilon}^C \alpha_j - \eta_{j1} s_{j1} \tag{20}$$

Proof of Proposition 1 In what follows we assume that all product and variety Engel curves are linear with respect to log household income. Taking a first-order Taylor approximations around $y^i = \bar{y}$ and assuming $s_j^i(\bar{y}) = s_j$ we can write $s_j^i = s_j + \beta_j(\phi^i - 1)$ where β_j is the slope of the EC for product j. We can then write the tax rate on a product j when all varieties are taxed as:

$$\tau_j^* = \frac{\int_i (\bar{g} - g^i)\phi^i (1 + \beta_j \frac{\phi^i - 1}{s_j})}{-g\epsilon_j} \tag{21}$$

The change in the optimal rate over the development path, holding efficiency considerations constant ($\partial \epsilon_j = 0$), can therefore be written as:

$$\partial \tau_j^* = \frac{\beta_j}{s_j}\left(\frac{\partial \beta_j}{\beta_j} - \frac{\partial s_j}{s_j}\right)\frac{\int_i (\bar{g} - g^i)\phi^i(\phi^i - 1)}{-g\epsilon_j} \tag{22}$$

where $\frac{\int_i (\bar{g} - g^i)\phi^i(\phi^i - 1)}{-g\epsilon_j} > 0$.

Similarly the tax rate on product j when only formal varieties are taxed is:

$$\tau_j^{**} = \frac{\int_i (\bar{g} - g^i)\phi^i (1 + \beta_{j1} \frac{\phi^i - 1}{s_{j1}})}{-g\epsilon_{j1}} \tag{23}$$

and

$$\partial \tau_j^{**} = \frac{\beta_{j1}}{s_{j1}}\left(\frac{\partial \beta_{j1}}{\beta_{j1}} - \frac{\partial s_{j1}}{s_{j1}}\right)\frac{\int_i (\bar{g} - g^i)\phi^i(\phi^i - 1)}{-g\epsilon_{j1}} \tag{24}$$

The first part of proposition 1 states that the redistribution gain from taxing all formal varieties uniformly is decreasing over the development path, ie that equity considerations push the optimal uniform rate τ_1^* downwards with development. Applying the above to the case of τ_1^*, we find that that, holding efficiency considerations constant, $\partial \tau_1^* < 0$ if the following condition holds:

$$\frac{\partial \beta_1}{\beta_1} < \frac{\partial s_1}{s_1} \tag{25}$$

The negative slope of the Informality Engel Curves implies $\beta_1 > 0$. Equity consid-

erations therefore push the optimal uniform rate down over the development path as long as the formal aggregate budget share s_1 increases faster than the slope of the Engel curve for all varieties β_1, which is minus the slope of the Informality Engel Curve depicted in the paper. This proves the first part of the proposition.

To prove the second part of the proposition, which relates to how the efficiency cost of taxing all formal varieties changes over development, start from expression (4) in the paper for a good consisting of all formal varieties. Writing η_1 this good's income effect, s_1 it's budget share, α the share of all formal varieties in total consumption, we obtain:

$$\epsilon_1 = \epsilon^C - 2\tilde{\epsilon}^C\alpha - \eta_1 s_1 = \epsilon^C - 2\tilde{\epsilon}^C\alpha - \eta_1(1-\alpha) \tag{26}$$

where the last expression is obtained by using $s_1 = (1-\alpha)$. The change in ϵ_1 over the development path, under our assumptions, can therefore be written as:

$$\partial\epsilon_1 = \partial\alpha(-2\tilde{\epsilon}^C + \eta_1) \tag{27}$$

As shown in the paper the size of the informal sector falls with development, so $\partial\alpha < 0$. The term is therefore positive as long as $\tilde{\epsilon}^C > \frac{\eta_1}{2}$. When this condition is met the price elasticity of demand for formal varieties increases over the development path, so the efficiency cost of taxing these varieties falls.

Proof of proposition 2 We start by proving the first part of the proposition, which states under which conditions the redistribution gain from taxing food less than non-food increases over development when all varieties can be taxed. This implies that, absent efficiency considerations, the optimal rate on food τ_F^* falls over development relative to the optimal rate on non-food τ_N^*. Using expression (22) above we obtain the following condition for $\partial\tau_N^* > \partial\tau_F^*$:

$$\frac{\beta_N}{s_N}\left(\frac{\partial\beta_N}{\beta_N} - \frac{\partial s_N}{s_N}\right) > \frac{\beta_F}{s_F}\left(\frac{\partial\beta_F}{\beta_F} - \frac{\partial s_F}{s_F}\right) \tag{28}$$

Rearranging and using the fact that $\beta_N = -\beta_F$ and $s_F = 1 - s_N$, we obtain:

$$\frac{\partial\beta_N}{\beta_N} > \frac{\partial s_N}{s_N}\frac{1-2s_N}{s_N(1-s_N)} \tag{29}$$

Where, as shown in the paper, we have $\partial s_N > 0$ and $\beta_N > 0$. There are two cases of interest. When households spend on aggregate more on non-food than on food ($s_N > 0.5$)—the case in most our countries—the right-hand-side of the expression is negative, so the condition holds as long as β_N (minus the slope of the food Engel curve) does not fall too much over development. This is the case described in the first part of proposition 2 in the text. If $s_N < 0.5$, the condition can still hold as long as $\partial\beta_N$ is positive and s_N does not increase too much relative to β_N. This case is arguably less empirically relevant. All else equal, the redistribution potential of taxing food and non-food at different rates is minimized when food and non-food are consumed in same proportions in the aggregate. An increase in the slope of the non-food Engel curve increases this redistribution potential. The redistribution potential will thus fall in a context in which s_N starts below 0.5 and increases, unless the slope of the Engel curve increases enough to compensate for the increase in s_N.

The change in efficiency cost of taxing food less than non-food over development, discussed in proposition 2, is governed by the relative values of $\partial\epsilon_N$ and $\partial\epsilon_F$. The uncompensated price elasticity of demand for product j is:

$$\epsilon_j = \epsilon^C - \eta_j s_j \tag{30}$$

Under our assumptions, the change in this elasticity can be written as:

$$\partial\epsilon_j = -\eta_j \partial s_j \tag{31}$$

Over development $\partial s_N = -\partial s_F > 0$, which implies $\partial\epsilon_N < \partial\epsilon_F$. The efficiency cost of taxing non-food products increases relative to that of taxing food: this pushes the optimal rate on food up relative to that on non-food over development.

Proof of Proposition 3 To prove the first part of proposition 3, we use expression (24) to write the change in optimal rates on food and non food when only formal varieties can be taxed, $\partial\tau_N^{**}$and $\partial\tau_F^{**}$. The condition for $\partial\tau_N^{**} > \partial\tau_F^{**}$ is:

$$\frac{\beta_{1N}}{s_{1N}}\left(\frac{\partial\beta_{1N}}{\beta_{1N}} - \frac{\partial s_{1N}}{s_{1N}}\right) > \frac{\beta_{1F}}{s_{1F}}\left(\frac{\partial\beta_{1F}}{\beta_{1F}} - \frac{\partial s_{1F}}{s_{1F}}\right) \tag{32}$$

Re-arranging, we obtain:

$$\frac{\partial \beta_{1N}}{s_{1N}} - \frac{\partial \beta_{1F}}{s_{1F}} + \frac{\partial s_{1F}}{s_{1F}} \frac{\beta_{1F}}{s_{1F}} - \frac{\partial s_{1N}}{s_{1N}} \frac{\beta_{1N}}{s_{1N}} > 0 \tag{33}$$

This expression holds if the non-food formal Engel curve slope increases more than the food formal Engel curve slope ($\frac{\partial \beta_{1N}}{s_{1N}} > \frac{\partial \beta_{1F}}{s_{1F}}$) and the non-food formal budget share doesn't increase too fast relative to the food formal budget share.

The second part states under what conditions the efficiency cost of taxing non-food goods increases relative to that of taxing food if only formal varieties can be taxed, ie $\partial \epsilon_{F1} > \partial \epsilon_{N1}$. Under our assumptions the change in the price elasticity of the formal variety of good j over the development path is given by:

$$\partial \epsilon_{j1} = -2\tilde{\epsilon}^C \partial \alpha_j - \partial s_{j1} \tag{34}$$

The condition $\partial \epsilon_{F1} > \partial \epsilon_{N1}$ is satisfied when:

$$2\tilde{\epsilon}^C (\partial \alpha_F - \partial \alpha_N) < \partial s_{N1} - \partial s_{F1} \tag{35}$$

This condition holds if, over development, the informal share of food consumption falls faster than that of non-food consumption ($\partial \alpha_F < \partial \alpha_N$) and the budget share of formal food varieties does not increase too fast relative to non-food.

D.2 Calibration

Here we explain how we calibrate tax rates under the three optimal policy scenarios defined in expressions (6), (8) and (9). Table 3 summarizes our choice of calibration parameters. First, we calibrate several parameters directly from our data: we use the observed budget shares shown in Section 4, household expenditure to proxy for household income and the the informal shares of consumption for each good and country. We relax our assumptions that Engel curves are log-linear and that development does not affect within-country inequality, using instead the observed budget shares and income distributions in each country.[32]

We use our data to obtain estimates of income elasticities for all goods and varieties. To obtain the income elasticity of demand for the formal variety, η_{j1} we

[32]Note that our model calls for using budget shares observed under a counterfactual 'no tax or transfers' scenario. We do not attempt to adjust observed budget shares to take into account the fact that they are affected by current tax systems as this is beyond the scope of this paper.

use our estimates of the slope of the formal Engel curve for good j, β_{j1}, and the expression $\eta_{j1} = 1 + \frac{\beta_{j1}}{s_{j1}}$. We obtain income elasticities η_j using $\eta_j = 1 + \frac{\beta_j}{s_j}$.

Second, we use existing literature to calibrate the remaining parameters. There are no estimates of the cross-price compensated elasticity of demand between formal and informal varieties $\tilde{\epsilon}^C \alpha_j$ so we use estimates of the elasticity of substitution in consumption across store-types. The cross-price elasticity is related to this elasticity of substitution σ in a CES utility function by the expression $\epsilon^C_{0,1} = \sigma s_0$ where s_0 is the share of informal consumption of total consumption of the good. Faber and Fally (2017) estimate an elasticity of substitution between large and small stores in the US of 2.2, Atkin et al. (2018b) estimate the elasticity of substitution between foreign and domestic supermarkets and find estimates in the 2-4 range. We therefore use 3 as our baseline of σ. For an average value of s_0 of 0.5 this yields a baseline value of $\tilde{\epsilon}^C \alpha_j$ of 1.5, we consider the range 1-2 as a robustness check. We set a value of -0.7 for the own-price compensated elasticity of goods. Together, these parameters yield values for the own-price uncompensated elasticity of goods (calibrated using expression (11) that are in the $[-2, -0.5]$ range, in line with estimates from the literature (see for example Deaton et al., 1994).

Finally, we specify government preferences by setting the same social welfare weight for households in a given decile of the household expenditure distribution in each country. The welfare weights are obtained to match an average uniform tax rate of 18%. This implies that governments place eleven times more weight on income received by households in the poorest decile than in the richest decile.

D.3 Personal Income Tax Extension

Model extension This section models optimal consumption tax policy in a context in which the government also levies a personal income tax (PIT). The PIT parameters, assumed exogenous, are an income threshold $\bar{y}$ above which households pay an income tax on their income $y^i - \bar{y}$, and a tax rate t_y. Household i's disposable income y^i_D after paying their PIT (but prior to any consumption taxes) can therefore be written as $y^i_D = (y^i - \tilde{y})(1 - t_y) + \tilde{y}$ if $y^i > \bar{y}$ and $y^i_D = y^i$ otherwise. The government sets optimal tax rates t_j on each good j to maximize:

$$W = \int_i G(v(p, y^i_D) + \mu \sum_j t_j q_{j1} x_{j1}$$

The PIT affects the indirect utility function, which is now a function of disposable post PIT-income y^i_D and household expenditure on each good x_{j1}, which is also (implicitly) a function of y^i_D. The first-order-condition for $\tau_j = \frac{t_j}{1+t_j}$ is:

$$\tau_j = \frac{\int (\mu - g_i) p_{j1} x^i_{j1}}{-\mu \epsilon_{j1} p_{j1} x_{j1}}$$

where both g_i, household i's marginal social welfare weight, and x^i_{j1} are now defined as a function of disposable income y^i_D. The existence of a PIT increases the welfare weight of households above the PIT threshold $\bar{y}$; all else equal this tends to decrease the optimal rate on goods consumed more by richer households, for example formal varieties of all goods. It decreases the consumption of the formal variety of good, $j1$, the more so the higher the income effect η_{j1}; this also tends to lower the optimal rate on goods consumed more by richer households. Over development Jensen (2019) documents a fall in the PIT threshold $\bar{y}$. This lowers the disposable income of richer households, by increasing taxes on existing taxpayers (increasing $y^i - \bar{y}$) and pushing new households into the tax net.

Calibration with Incomes Taxes We obtain the PIT parameters $\bar{y}$ and t_y for each country from Jensen (2019) where available. For the 10 countries for which no data is available, we interpolate the parameters using the observed relationship between these parameters and each country's log GDP. The parameter $\bar{y}$ is expressed as a percentile of the household income distribution. We then compute each household's disposable income y^i_D using the definition given above and total expenditure per capita to proxy for income y^i. From this, we obtain each households' consumption x^i on each good and variety as a function of its disposable income: for example $x^i_{j1}(y^i_D) = x^i_{j1}(y^i) + \eta_{j1} \frac{x^i_{j1}(y^i)}{y^i}(y^i_D - y^i)$, where $x^i_{j1}(y^i)$ is household i's expenditure on the formal variety of good j observed in the data. We use the estimates of income elasticities obtained using our data, see table 3.

To calibrate the change in the marginal social welfare weight g^i due to a PIT, we specify $g^i(y^i) = \frac{-\alpha}{y_i}^2$. This functional form is what we would obtain if we specified a log indirect utility function $v()$ and a utilitarian social welfare function $G()$. We calibrate it to obtain the distribution of the g^i terms of our baseline specification (Table 3). The new weight g^i is then given by $g^i(y^i_D) = g^i - \frac{\alpha}{y^{i2}}(y^i_D - y^i)$.