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Abstract

Can taxes on consumption redistribute in developing countries? Contrary to consensus, we show that taxing consumption is progressive once we account for informal consumption. Using household expenditure surveys in 32 countries we proxy for informal consumption using the type of store where purchases occur. We establish that the budget share spent in informal stores steeply declines with income, so that richer households pay a substantially larger share of their income in taxes. Our findings imply that the widespread policy of exempting food from taxation is hard to justify on equity grounds in low-income countries.

JEL: E26, H21, H23, 023

Keywords: Budget Surveys, Inequality, Informality, Redistribution, Taxes.

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1 Introduction

Income inequality in developing countries is often higher than in rich countries and has not decreased over the past 30 years (Alvaredo and Gasparini, 2015). Rich countries achieve significant redistribution via broad-based income taxes, but the income tax base covers only a fraction of the income distribution in developing countries, due in part to enforceability constraints (Jensen, 2022). Instead, developing countries rely primarily on indirect consumption taxes to collect revenue, which are perceived as inequitable when applied uniformly. To introduce progressivity, most countries apply reduced rates on necessity goods, in particular food items. What is the redistributive potential of consumption taxes? Do policies that reduce rates on necessity goods actually decrease inequality?

In this paper we answer these questions by providing the first systematic investigation of the redistributive capacity of consumption taxes in developing countries. The literature in public finance and development focuses on the impacts of informality on revenue and efficiency (Besley and Persson, 2013; Best et al., 2015), but abstracts from the redistributive consequences of a large informal sector. We innovate by developing a method to measure how informal consumption varies with household income, both within and across countries. Our analysis yields two main findings. First, due to a large reduction in informal consumption along the income distribution, uniform consumption taxes are progressive and reduce inequality. Although intuitive, this result runs counter to the consensus view that taxes on consumption are regressive (Warren, 2008). Second, the redistributive impact of reduced rates on necessities is limited because of the large overlap between consumption of necessity goods and from the informal sector. Our findings imply that exempting food from taxation is hard to justify on equity grounds.

Our starting point is the construction of a micro database combining expenditure surveys from 32 low and middle income countries, spanning income levels from Burundi to Chile. Since surveys never ask if taxes were paid on a purchase (and respondents might not know), we innovate by using the store type reported for each purchase to proxy for informal sector consumption. This approach is motivated by the vast disparities in consumption by place of purchase across countries: Figure A1a-A1b shows that economic development is associated with a steep rise in consumption in modern stores (supermarkets, specialized stores),

which replaces consumption in traditional stores (home production, street stalls, corner stores). Modern and traditional stores differ in key characteristics which determine formality, including size, organizational structure and interaction with third-parties. In our baseline formality assignment, we assume that taxes are remitted on purchases from modern stores but not from traditional stores.

We use this database to document new facts on consumption patterns across the household income distribution and between countries. We show the existence of a downward sloping Informality Engel Curve (IEC): the informal budget share steeply declines with household income in every country. On average, doubling households' income is associated with a 10 percentage points drop in informal consumption. Our data also allows us to study patterns of informal consumption within goods. We focus on food versus non-food since most developing countries tax food items at a reduced rate. Accounting for informal consumption fundamentally alters the goods level patterns: while the overall food Engel curve is steeply downwards slopping 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) rises with income. For a country at the mean income level of our sample, a uniform tax rate levied on all formal consumption is strongly progressive due to the downward-sloping IECs: the effective tax rate of the richest decile of households is over twice that of the poorest decile. In contrast, the progressivity gain from exempting food (while taxing non-food) is low, since a large share of poor households' food consumption occurs in informal stores and from home production.

The progressivity achieved with a uniform rate falls with development. This is because the aggregate informal budget share is larger in poorer countries, which, combined with a negative IEC slope, implies that formal purchases are a strong tag for high income households (Akerlof, 1978). As the aggregate informal budget share shrinks with development, formal purchases become a weaker income tag. In contrast, exempting food from taxation produces no progressivity gains in the poorest countries, but leads to moderate gains in upper-middle income countries. Failing to account for informality leads to an overestimation of equity gains from food exemptions in all countries, but particularly in poorer ones.

The pass-through rates of taxes to formal and informal retail consumer prices are key parameters to quantify the distributional impact of consumption taxes. Our baseline results assume a full (zero) pass-through of taxes to formal (informal) prices. To our knowledge, pass-through rates in the presence of an informal sector have not been estimated before, due to the paucity of data on informal prices and limited exogenous variation in indirect tax rates. We exploit a reform which changes the consumption tax rate from 11 to 16% in Mexico in 2014, only for firms located in border municipalities. Using price quotes from both modern and traditional stores (to proxy for formal and informal prices) and a difference-in-differences design, we find a small, but non-zero, tax pass-through in traditional stores (16%), and a large one in modern stores (75%), although less than one. We subject our results to a battery of robustness checks related to identification and measurement, and explore additional impacts of the reform.

We then revisit our analysis on the progressivity of consumption taxes allowing for pass-through between formal and informal stores to differ from 100%. First, when applying our estimates from Mexico to all countries, we find that top decile households still face an effective tax rate that is 70% higher than that of bottom decile households under a uniform tax rate. Second, with positive pass-through to informal prices, food exemptions produce larger progressivity gains, though they remain limited in magnitude.[1]

We study the implications of our results for tax design and inequality, by extending Diamond (1975)'s multi-person model of optimal commodity taxes to allow for formal and informal (untaxable) varieties of each good. The model accounts for both the equity and efficiency implications of informal consumption: introducing informal varieties raises the efficiency cost since households substitute consumption towards them when taxes increase. This cost decreases over development as the informal sector shrinks. Calibrating the model to our data, we find that the optimal level of rate differentiation between food and non-food increases with development. In low-income countries, reduced rates often cannot be justified on equity grounds. An extended model which allows for producer prices to respond endogenously, calibrated using our estimates from Mexico's

[1]These results are qualitatively robust to allowing for larger informal pass-through than the Mexican estimate. This is because non-market consumption (home production)—for which pass-through is unlikely—represents a large share of overall informal consumption in poor countries.

reform, yields similar policy prescriptions.

To measure the impact of consumption taxes on inequality, we combine the calibrated rates with our microdata. We find that setting optimal uniform rates reduces the Gini coefficient by 2% on average: 1% in low-income countries and 3% in upper middle-income countries; with rate differentiation, the inequality reduction ranges from 1.1% to 3.9%. We also incorporate personal income taxes in our model and calibration. In theory, the presence of perfectly enforceable income tax renders redistribution through consumption taxes suboptimal (Atkinson and Stiglitz, 1976). In practice, the prevalence of self-employment forces governments to tax only the very top of the income distribution (Jensen, 2022); the resulting narrow tax base limits the redistributive potential of income taxes. Thus, taking into account existing income taxes does not substantially affect our findings.

In summary, we show that uniform taxes on consumption are mildly progressive due to informal consumption patterns. This result is hard to establish due to stringent data needs: it requires a proxy for both formal and informal purchases and link them to household income. More generally, our paper is the first to systematically investigate the equity effects of consumption taxes in developing countries.[2] It integrates the two most relevant channels which impact tax progressivity: the informal sector (de-facto exempt) and reduced rates on necessities, in particular food (de-jure exempt). Our simple framework measures consumption taxes' progressivity, and calculates optimal rates and inequality impacts. We also provide new evidence on the pass-through of taxes to modern and traditional store prices in one country. Yet, our framework is general and can incorporate new pass-through estimates as they become available in other countries.

Our analysis points to the low redistributive potential of reduced rates on necessities, a widespread policy worldwide.[3] More broadly, our results emphasize that policy-makers need to account for the informal sector's distributional impacts when designing fiscal policy. This insight complements the tax capacity framework of Besley and Persson (2013), which focuses on policies raising tax revenue and largely abstracts from equity considerations. Our results do not imply that enforcement policies expanding the tax net to small firms should be abandoned,

[2]Prior policy reports and individual country studies suggest a role for the informal sector in determining the equity impacts of consumption taxes (Lustig, 2018; Jenkins et al., 2006).

[3]Country reports from the International Bureau of Fiscal Documentation show that 90% of developing countries differentiate consumption tax rates, especially for food and non-food goods.

but caution that revenue benefits must be weighted against equity costs.

1.1 Literature

Our paper contributes to three distinct literatures. First, our micro data allows us to construct a consumption based measure of informality at the household level, which complements firm and worker level measures (La Porta and Shleifer, 2014; Gerard and Gonzaga, 2016; Ulyssea, 2018). We document how consumption by place of purchase varies with household income both within countries and across development, relating to studies on aggregate changes in consumption across countries (Bronnenberg and Ellickson, 2015; Lagakos, 2016; Atkin et al., 2018b).

Second, we contribute to the literature on tax design in low capacity settings. Except for recent work on wealth taxes (Londono-Velez and Avila-Mahecha, 2021), studies on tax and development rarely analyze equity implications of imperfect enforcement, but focus on revenue consequences (Pomeranz, 2015; Naritomi, 2019; Waseem, 2020), and societal benefits from improved tax collection capacity (Casaburi and Troiano, 2015; Gadenne, 2017; Weigel, 2019; De Simone, 2020). Our main finding runs counter to the consensus view that indirect taxes are regressive. This previous view is however based on limited evidence which ignores informal consumption (Sah, 1983; Harris et al., 2018). Moreover, evidence on the impacts of tax rate differentiation across goods is scarce in developing countries, despite their prevalence (Gemmell and Morrissey, 2005).

Third, our paper relates to studies on the equity implications of distributional consumption patterns, so far focused on rich countries (Faber and Fally, 2017; Jaravel, 2019; Allcott et al., 2019). We estimate a new tax incidence parameter, the tax pass-through to informal stores' prices. This contributes to the literature showing that pass-through of taxes to prices varies with market structure and tax design (Marion and Muehlegger, 2011; Benzarti et al., 2020).

2 Data

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

2.1 Data Sources and Selection Criteria

We assemble our main dataset by combining household expenditure surveys from countries that satisfy three criteria. First, the survey must be nationally representative. Second, the survey must record consumption from open diaries rather than prefilled diaries (which only cover selected goods), to help ensure that all expenditure types are covered. 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. This last criterion ensures that we can apply our method to infer consumption from informal sources, 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 principally located in Latin America and Sub-Saharan Africa. Unfortunately, most household expenditure surveys in Asia do not contain information on the place of purchase. Appendix B provides further details on the data construction.

2.2 Measuring Consumption by Store Type

Our objective is to measure consumption by place of purchase. A challenge is that the 32 surveys do not share the same design. To achieve international comparability, we create a taxonomy of place of purchases, 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 (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 are 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).[4] These categories account for 86% of total household expenditure. The remaining 14% are items for which no place of purchase is specified, primarily utilities and fuel (see Figure A2).

We use an aggregated store classification for our main analysis, assigning cat-

[4] All original store types in all surveys, and our classification, is shown in the online appendix.

egories (1) through (3) to the *traditional store type*, and categories (4) and (5) to the *modern store type*.[5] This follows the modern-traditional classification commonly used in cross-country academic studies (Humphrey, 2007; Lagakos, 2016) and market research on global retail patterns, which is based on the logic that differences in retailing across space and time are meaningfully captured by these two retail groups: stores within each group share similar characteristics but are systematically different across groups in terms of sales, market orientation, and organizational structure. Further, as discussed in Section 3, these store types differ 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

Mexican micro-prices and retail census We use two datasets from Mexico. First, we use the confidential monthly price quotes collected by the statistics office to construct the consumer price index. This data samples prices for all items, stores, and locations representative of Mexican consumption (including the traditional sector). Second, the 2013 Census collects information on all retailers, including taxes levied on sales and paid on inputs. Importantly, both datasets detail store types in a manner consistent with our cross-country taxonomy (Section 2.2), with the caveat that home production is not included (details in Appendix C.1).

Euromonitor retail data We use country specific retail reports produced by the market research firm Euromonitor International, which include the number of outlets and total sales for modern and traditional food stores in 189 countries. The modern and traditional categories are consistent with our classification, except that Euromonitor does not measure home production. See Appendix C.1 and Bronnenberg and Ellickson, 2015 for details on the data collection.

[5] We explain how we assign services when we discuss the tax status by store type in Section 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 provide supporting evidence.

3.1 Characteristics of Modern & Traditional Retailers

Modern and traditional stores differ in characteristics which are key determinants of tax enforceability. Figure A1 shows that the average modern store has forty times more sales than the average traditional store, and occupies twenty times more floor space. Traditional stores stay at a constant small size in all countries, except for the richest ones, and the first order change in retailing patterns as developing countries get richer appears to be the growth of modern retailing, as opposed to the expansion of traditional retailers' size and sales. This size difference translates into a higher enforcement intensity since tax administrations devote more resources to monitor larger firms (Basri et al., 2019). Further, modern retailers' size imply that they serve more customers, employ more workers, and hold inventories. The public finance literature convincingly shows that information trails, through accounting records and third-party reports (customers, employees, suppliers) are key determinants of tax enforcement success (Kleven, 2014; Pomeranz, 2015; Naritomi, 2019). Modern stores' size and information trails imply that they are much more likely to be tax compliant than traditional stores.

3.2 Assignment of Formality by Store Type

Baseline assignment Our definition of formality is based on the likelihood of taxes being levied on consumer prices in a given 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 (category 6) are formal while individual providers are informal (category 7).[6]

[6]Similarly, we assign unspecified expenditures to formal, since they mainly consist of utilities provided by large firms (Figure A2). In the online appendix., we show for each country the original names of places of purchase, their expenditure shares and our formality assignment.

Within country evidence The baseline assignment presents the advantage of relying on an observable characteristic which is comparable across countries. While the store type is an ex-ante characteristic that captures potential formality status, we show that it strongly correlates with ex-post actual formality. The Mexican retail census collects information on consumption tax (VAT) payments for all retailers: we find that only 9.5% of traditional stores report remitting these taxes, whereas most modern stores do (Figure C1).

To our knowledge, other countries' censuses do not record information on both tax status and store types. To measure formality by store type across countries, we instead combine data from the World Bank Enterprise and Informal Surveys (WBEIS) and the Euromonitor retail reports. The WBEIS surveys measure tax registration and sales of retailers, but not store type, in 35 developing countries. The retail reports document the average sales of modern and traditional retailers in those same countries. Combined, these data allow us to estimate the formality share in modern (traditional) stores, based on where the average sales of modern (traditional) stores intersects the sales distribution of formality.[7] We find that the formality share in modern stores is 80-90%, the formality share in traditional stores is 10%, and formality shares within store types are fairly constant across countries (Figure C2). This suggests that our country-invariant assignment of formality status to store type is reasonable. Further, the stability of the formality of traditional and modern stores across countries is consistent with the view that the rising consumption tax base over development is driven by the growth of modern retailing rather than by changes in enforceability within store types.

Exemption thresholds The tax status of a store is driven by the extent of enforcement on stores which are legally obliged to comply with consumption taxes. In addition, stores can be legally exempted from taxes if their size falls below the registration threshold. We collect values of the VAT registration thresholds in our sample countries: the ratio of average sales to the threshold is 1.0 for traditional stores and 38.9 for modern stores (Appendix C.1). This suggests that the vast differences in formality share between store types also occur due to the tax code: many traditional stores' sales places them below the threshold, which im-

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

plies that they are not legally required to remit taxes. On the contrary, the size of modern stores compels them to remit taxes. The level of the exemption threshold is itself endogenous to enforcement constraints: tax administrations know that the revenue yield from taxing small stores can be minor relative to administrative and compliance costs and thus often choose to exempt them (Keen and Mintz, 2004). We discuss in section 7.2 below how we use our model to study the equity-efficiency trade-off associated with changing the threshold.

Summary Our baseline assignment of modern stores as formal and traditional stores as informal appears reasonable given the descriptive evidence. This assignment is transparent and constitutes our starting point, but we show robustness to using country-specific formality shares by store types detailed above. Importantly, we initially assume that consumption taxes are fully passed through to consumer prices in formal stores and not at all in informal stores. In Section 6, we revisit this stylised assumption and show quasi-experimental evidence on the relative price pass-through of a Value-Added-Tax reform in Mexico.

4 Engel Curves of Informality and Food Across Development

In this section, we show how informal consumption varies with household income within and between countries, and investigate the determinants of these variations. We then document how food and non food consumption differ across stores, and 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, 1997; Atkin et al., 2018a). We use the logarithm of total household expenditure per person, in line with the literature on Engel curves (Deaton, 1997). For illustrative purposes, Figure 1 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 regres-

sions. 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 falls from 55% to 25%. We find two empirical regularities in the full sample. 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.[8]

We summarize the information contained in the country-level IECs with: i) the aggregate informal budget share; ii) the slope of the IEC. These two moments are sufficient to characterize the tax progressivity impacts of consumption patterns (See Section 5). Figure 2 plots the aggregate informal budget share (2a) and the estimated IEC slope (2b) against countries' GDP per capita. Figure 2a reveals a large drop in the aggregate informal budget share, from 90% in the poorest countries to 20% in upper-middle income countries. In Figure 2b, we observe that the negative IEC slope first increases in magnitude, between low-income to middle-income countries, and then slightly falls, between middle and upper-middle income countries. The average IEC slope is -10.2, implying a 1 percentage point drop in informal budget share for a 10% rise in household expenditure. Figures A4-A5 show consumption shares by decile for more detailed store types.

4.2 Differences in Informal Consumption across Households

We investigate four key hypotheses in the literature explaining informal consumption differences. First, poor and rich households differ in characteristics which, through economies of scale and life-cycle patterns, might impact store-choices (Deaton and Paxson, 1998). We estimate the following regression in each country:

$$Share\ Informal_i = \beta * ln(expenditure_i) + \Gamma X_i + \varepsilon_i \tag{1}$$

where X_i are characteristics of household i (household size, age, education and gender of household head). Table 2 shows the average of the slope coefficients β across countries. Including household characteristics account for almost none of the IEC slope (column 2). The second hypothesis is that poor households' access

[8]Country level IECs are plotted for all 32 countries in the online appendix and are often log-linear. Similarly, Almås (2012) finds stable log linear food Engel curves around the world. Yet, for narrow goods, Engel curves can be non-linear and vary across countries (Atkin et al., 2018a).

to formal stores is limited (Lagakos, 2016). We find that access matters, but only to a limited extent: controlling for rural location (column 3) or including block fixed effects (column 4) reduces the average slope by 16% and 28%, respectively.

The third hypothesis is non-homothetic preferences: richer households spend more on goods sold in formal stores. To test this, columns 5-8 show product-level versions of (1).[9] Preferences play a significant 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). More narrow categories only slightly reduce the slope further (columns 7-8).

The fourth hypothesis is that richer households value higher quality varieties which are more likely to be sold in formal stores. Such taste based preference heterogeneity is unobservable in equation (1). Yet, in selected surveys, households report the main reason for choosing a place of purchase by item. Table A1 indicates that, both between and within households, formal (informal) purchases are more often motivated by higher quality (lower prices).[10] The quality-price trade-off hypothesis implies that formal varieties of a good should be more expensive than informal varieties. Focusing on food products to mitigate comparability issues, Table A3 shows that prices are 6.7% higher in formal than informal stores.

The descriptive results in this section have two main implications for the design of consumption taxes, which we study in Section 7. First, the large overlap between expenditure in informal stores and expenditure on food implies that a country's redistributive potential from food exemptions will depend on the prevalence of informal consumption. Second, even after including extensive controls in equation (1), the average IEC slope remains large and statistically significant. Combined with our additional results on the price-quality trade-off for informal consumption, this suggests that the IECs may be driven by non-homotheticity and reflect between-income preference heterogeneity. This will be our interpretation when we use the IEC slopes to derive optimal tax rates.

[9] We estimate: $Share\ Informal_{ig} = \beta * ln(expenditure_g) + \alpha_g + \Gamma X_i + \varepsilon_{ig}$ where $Share\ Informal_{ig}$ is the share of household i's informal expenditure on good g and α_g are goods fixed effects.

[10] 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).

4.3 Consumption Patterns of Food and Non-Food Formal Goods

To make consumption taxes more equitable, most countries set reduced (or zero) rates on food.[11] These policies are motivated by the steep downward slope of the food Engel curve, a pattern extensively documented (Anker et al., 2011). It is thus relevant to investigate how the well-established food Engel curve changes once we focus on formal food consumption. Figure 3 shows for all sample countries the aggregate budget shares and Engel curves slopes, for total food consumption (Figures 3a and 3b), and formal food consumption (Figures 3c and 3d). While the total budget share spent on food falls as countries get richer, the budget share on formal food *rises*. Within country, the food Engel curves' slopes are strongly negative, but the formal food Engel curves have small *positive* slopes in low income countries, and become negative in upper-middle income countries.

Figures 3e-3f show the aggregate budget shares and Engel curve slopes for formal non-food. The budget share devoted to formal non-food consumption strongly grows across countries, from less than 20% in the lowest-income countries to 60% in upper-middle income countries. Similarly, the positive formal non-food Engel curve slopes triples over development.

5 How Progressive are Consumption Taxes?

In this section we analyze how these novel consumption patterns affect the progressivity of consumption taxes.

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 income tagging literature (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. To build intuition, consider a good with an upward sloping and linear Engel curve with respect to log household income (e.g. formal goods and non-food goods).

[11] Some countries apply reduced rates to all food goods and others target 'basic' food. For illustrative purpose, we follow the former approach. Targeting narrower items can improve redistribution, but increases the possibility for misreporting and the compliance/legal costs.

Holding the aggregate budget share constant, an increase in the steepness of the Engel curve slope makes the good a better tag of income. Similarly, holding the (positive) slope constant, a decrease in the aggregate budget share makes the good a better income tag, since it is more likely that a purchase of that good is made by a rich household. Thus, the progressivity achieved by taxing this good increases with the slope of its Engel curve and decreases with its aggregate budget share.

Results We study the progressivity of three tax policy scenarios. Scenario 1 applies a uniform tax rate on all goods consumed from formal retailers to illustrate the progressivity of our new informality channel. Scenario 2 sets a zero tax rate on food and only taxes formal non-food consumption. This captures the combined progressivity impact of the (de-facto) exemption of informal stores and the (de-jure) policy exemption of food products. Comparing scenario 2 to 1 reveals the progressivity gain from exempting food when only formal consumption can be taxed. Scenario 3 applies a zero rate on food goods, but assumes that taxes are paid on expenditures from all store types (including home production). This corresponds to the unrealistic assumption of perfect enforcement. Comparing the progressivity achieved by scenario 3 to that achieved when moving from 1 to 2 captures how much failing to account for informality leads to incorrect conclusions on the progressivity gains from food exemptions. We assume that governments set rates to collect 10% of total consumption in taxes in each scenario.[12]

Figure 4 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 fairly progressive. Under scenario 1 (in red), 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 sloping in all countries (Figure 2b).

Second, the marginal progressivity achieved by exempting food when only formal consumption is taxable is limited: when moving to scenario 2 (in orange) from scenario 1 (in red), the increase in progressivity is quantitatively small. This

[12]The simulations are mechanical: households consumption behavior is not affected by the level of tax rates. We initially assume hand-to-mouth consumers but can allow for saving rates that vary across the income distribution, using the the Global Findex Database (Demirguc-Kunt et al., 2018). As expected, savings slightly reduces progressivity (Table A2 and Figure A7).

is because the formal food Engel curve slope's is positive in many countries, unlike the total food Engel curve (Figure 3f).

Third, the progressivity gain from exempting food in the realistic setting with informal consumption is much smaller than the progressivity gain in unrealistic scenario 3 (in green) with perfect enforcement. Comparing scenarios 1 and 2, we see that exempting food raises the effective tax rate of the richest quintile relative to the poorest quintile from 2 to 2.2, a 10% progressivity gain. In contrast, under scenario 3 exempting food leads to the richest quintile paying a 60% higher effective tax rate.[13] Ignoring informal consumption leads to a large over-estimation of the progressivity gains from exempting food. This is because the slopes of food Engel curves are strongly negative everywhere (Figure 3b) while those of formal food Engel curves are either positive or mildly negative (Figure 3d).

5.2 Progressivity Across Countries

How does the progressivity of taxing different goods change across countries? To answer this question, we compute for each country the log of the ratio of the effective tax rate paid by the richest quintile relative to the poorest quintile, in the three tax scenarios. A positive (negative) log-value corresponds to a progressive (regressive) tax base. Figure 5 plots this ratio for each of our three tax scenarios as a function of countries' income per capita. Three main results emerge.

First, taxing only formal consumption is progressive everywhere, but more so in low-income countries (Figure 5a). In the poorest countries, a uniform rate levied on formal consumption leads the share of income paid in taxes to be 3.5 times larger for the richest quintile than the poorest. In the richest countries, this number is only 30%. The IEC slope slightly grows with development (Figure 2a), which increases the progressivity of taxing formal consumption. The large fall in informal budget shares as countries develop (Figure 2b), however, reduces progressivity. In practice, the 'base effect' dominates the 'slope' effect, making formal consumption a worse tag for household income as countries develop.

Second, exempting food from taxation meaningfully increases progressivity only in upper-middle-income countries. Figure 5d shows this by comparing the

[13] Formally, the progressivity effect from this scenario is the difference between the green line and the horizontal line at 10%, since not tax exempting food in a scenario where all consumption is taxed would lead to constant effective tax rates along the income distribution (neutral tax system).

progressivity achieved from under a uniform rate (red line, replicated from Figure 5a) to that achieved from tax exempting food (orange line, replicated from Figure 5b) when only formal consumption is taxed: the difference between the two lines captures the progressivity gain of food exemptions. This gain is negligible for the poorest countries, because the *formal* food Engel curve is positive at low development levels (see Figure 3d) and only becomes negative in upper-middle income countries, where we start observing progressivity gains from food exemptions.

Third, assuming perfect enforcement leads to a much stronger over-estimation of the progressivity gains from food exemptions in poorer countries. Figure 5c plots the progressivity gains from exempting food under the unrealistic assumption that taxes can be enforced on all consumption.[14] These gains are always larger than those obtained under the realistic scenario of no taxes paid on informal consumption (difference between the red and orange lines in Figure 5d); the difference is largest in the poorest countries and decreases over development.Intuitively, the over-estimation of the progressivity gains from exempting food under the assumption that all consumption can be taxed, is reduced over development: as the modern retail sector grows this assumption becomes a better approximation of reality. In low-income countries this unrealistic assumption leads to particularly erroneous conclusions on the merits of food exemptions.

6 Pass-through of Taxes to Informal Sector Prices

The above results on progressivity are obtained under an assumption of 100% (0%) tax pass-through to consumer prices in modern (traditional) stores. In this section, we directly estimate the pass-through of taxes by store type in Mexico and discuss how progressivity is affected by different pass-through assumptions.

6.1 Pass-through by Store Type: Evidence from Mexico's VAT reform

To estimate pass-through we require nationally representative consumer price data separately by store types and credibly exogenous variation across stores in

[14]These gains are the difference between the green and the horizontal line at zero, since not exempting food when all consumption is taxed would lead to constant taxed budget shares along the income distribution (neutral tax system). Note that the progressivity gains from exempting food under this unrealistic scenario also fall with development, since the aggregate food share decreases with development, making the taxation of all formal food a worse income tag.

the VAT rate. Micro price data by store-type do not exist in most of our 32 countries, however. Moreover, the standard statutory VAT rate is often set nationwide, making it challenging to establish a credible counterfactual.

These requirements are stringent in general, but satisfied in Mexico, which collects high-frequency price data separately by store-types that correspond to our modern-traditional taxonomy. A VAT reform in 2014 provides spatial variation within country over time in the standard rate faced across stores. In January 2014, the VAT increased from 11% to 16% in border areas to equal the non-border rate which remained at 16%. This preferential tax zone was set to discourage cross-border shopping. Border areas were initially defined as lying within 20km of an international border; over time, lobbying by sub-national governments led to the expansion of the zone to include other areas, as shown in Figure A14.

Our identification strategy leverages the spatial and temporal variation in the VAT rate by comparing prices in each store type (modern, traditional) between treated border areas and control non-border areas over time. We rely on confidential price data collected by Mexico's National Institute of Statistics and Geography (INEGI) for products in cities with at least 20,000 inhabitants spread across the country. This data underpins the Mexican CPI. Stores and products are selected based on representative household surveys (See Appendix C.2 for details). We average quotes by month, product, location and store-type and make three sample restrictions. First, we focus on taxed products as defined in the Mexican VAT law. Second, since the treatment variation is spatial, we focus on non-tradable products to avoid potential cross-location spillovers.[15] Third, as INEGI occasionally changes the set of quoted products, we focus on a balanced set of products.

Our difference-in-differences (DD) design recovers the causal impact of the VAT increase on prices if there are no changes to unobservable factors that coincide with the reform, and differentially impact prices in border versus non-border stores. We implement a flexible regression model which includes all month dummies between January 2013 and January 2015. Formally, we estimate:

$$lnp_{glt} = \sum_{t} \beta_t (Border_l * Period_t) + \mu_g + \mu_l + \mu_t + \epsilon_{glt} \tag{2}$$

[15] We follow the classification in Mariscal and Werner (2018). As the treatment varies at the local level, including tradable goods would lead us to underestimate the level of VAT pass-through if households buy tradables across areas (Benzarti and Carloni, 2019; Harju et al., 2018).

where lnp_{glt} is the log of the VAT-inclusive price of product g in location l at time t; $Border_l = 1$ if the location is in the border areas, μ_g, μ_l, and μ_t are fixed effects at the product, location and time level. Standard errors are clustered at the product-location level and we use store-product level weights provided by INEGI to be representative of national expenditures. We estimate the coefficient of interest β_t separately in modern and traditional stores.

The top panels of Figure 6 show the results. Prices in modern and traditional stores evolve similarly in treatment and control areas prior to the reform. We observe a sharp price increase in the post reform period in treated modern stores. By estimating the DD version of Equation 2, we find that the average pass-through in modern stores is highly significant and equals to 3.75 percentage points (75%). In contrast, we see little effect on traditional stores: prices slightly rise in the immediate post implementation months and then slowly decline. The DD estimate of the average pass-through in traditional stores is 0.8 percentage points (16%) but not statistically significant at conventional levels.

The middle panels of Figure 6 present robustness checks related to measurement. First, we find slightly larger effects in modern stores (unchanged effects in traditional stores) when removing product weights. Second, researchers working with consumer micro-data have highlighted that price time-series can be volatile (Nakamura and Steinsson, 2008): our results are robust to winsorizing the top and bottom 5% prices by period, treatment status and store-type. Third, the less than full pass-through in modern stores and the positive (but small) pass-through in traditional stores may reflect the imperfect mapping from store types to tax status (Figure C1). We merge the 2013 Mexican retail census with the INEGI data to re-estimate pass-through by tax status, distinguishing between formal stores that levy VAT on sales and informal stores that do not (Section Appendix C.1). We find that the pass-through rate in formal (informal) stores is very similar to the pass-through rate in modern (traditional) stores.[16]

In the bottom panels of Figure 6, we study robustness of the spatial treatment assignment. We find similar pass-through when we restrict control locations to

[16]Census tax status is self-reported and the uncertainty over actual formality is highest for corner stores. However, we find that the pass-through in these stores is identical to the overall traditional pass-through. Further, removing stores part of national chain does not change the pass-through in modern stores, alleviating concerns that pass-through is understated due to chain stores uniformly pricing across treated and control areas (DellaVigna and Gentzkow, 2019).

only include cities in border states. Thus, our results do not hinge on a specific spatial definition of the control group. Our results are also unchanged when we exclude Mexico City from the control group: given the capital's importance in the national economy, this alleviates concerns that our use of nationally representative expenditure weights introduces bias via differential trends in the capital. Our final robustness check addresses heterogeneity concerns related to the northern border, which is subject to intense policy focus. Other reforms affecting the northern area may have occurred post-reform, or retail pricing strategies in the area may have evolved differently due to cross-border US shoppers. However, we find that pass-through estimates are similar when using only the northern border area.

We provide three final explorations of the Mexican reform. Optimal tax prescriptions, and our model below, are based on long-run incidence parameters, which makes it important to consider if the pass-through changes over time. For example, consumers may only gradually respond to the VAT increase by substituting consumption from modern to traditional stores, leading to a pass-through in traditional stores that increases over time. In Figure A6, we expand the post-period by 12 months: the pass-through rates remain remarkably stable over the 24 post-reform months. The DD estimates of 3.75 in modern stores and 0.8 in traditional stores are extremely close to the short-run estimates, thus longer-run reform effects seem to materialize in the immediate post-implementation months.

Second, we study the potential impacts of the VAT reform on store presence, using several rounds of the retail census (2008, 2013, 2018). Importantly, we are able to track firm-IDs between census waves. Our outcome variable is a dummy equal to 1 if a specific store-ID is present in a given Census round. In Table A6, we estimate if the rate of stores' presence between 2013 and 2018 differs between treated border cities and non-border control cities. We compare this rate of change to a placebo set of years between 2008 and 2013. The results show a (very) small decrease in the presence of modern stores following the VAT rate increase, though it is not statistically significant at conventional levels.

Third, we investigate whether pass-through estimates are driven by the VAT paid by traditional stores on their inputs (Keen, 2008). In Appendix D.1 we show that the pass-through rate of VAT in traditional stores should equal the share of intermediate product costs purchased from VAT-registered suppliers. Using the Mexican retail census, we measure the VAT input cost-share of traditional

retailers to be 10%. The 10% pass-through implied by formal input-sourcing may have contributed to our estimated pass-through of 16% in traditional stores.

In summary, we find that the pass-through of a reform induced VAT burden to consumer prices was almost five times larger in modern stores than in traditional stores. These estimates are stable in numerous checks, and we use them in the following subsection to gauge the robustness of our progressivity calculations.

6.2 Implications for Progressivity Results

Figure 7 shows the robustness of our progressivity results from assigning the pass-through rates estimated in Mexico to modern and traditional stores in all sample countries. Concretely, we assign a difference in pass-through of 59 percentage points—since the estimated pass-through in modern stores (traditional) was 75% (16%)—rather than the 100pp differential pass-through in the baseline assignment. We maintain a zero pass-through for non-market consumption. Assuming some pass-through to informal prices reduces the progressivity of a uniform tax, on average across countries (dashed line in Panel A). Moreover, as informal consumption becomes a weaker tag of poorer households due to higher pass-through, the relevance of food as a tagging device improves. This can be seen in Panel B, where the marginal progressivity gain from applying an exemption to food is higher with the Mexico estimates than with the baseline. Applying Mexico's estimate leads to a larger reduction of uniform rates' progressivity impact in lower-income countries (Panel C). This is because the low level of formal consumption in poor countries makes it an especially good tag for high-income households (Section 5.2); the tagging power is disproportionately reduced in these countries when the pass-through difference between store types declines. Yet, given the strong overlap between informal consumption and food consumption at low-income levels (Figure 3), a positive price pass-through in informal stores raises the progressivity of food exemptions in poorer countries (Panel D).

Assuming pass-through rates based on Mexico's evidence does not overturn our findings, but quantitatively reduces the progressivity of uniform taxes and raises the relevance of food exemptions, especially in poorer countries. While the Mexican pass-through is well-identified, it might not apply to other countries: to account for uncertainty in the value of this key parameter, the four panels in Figure 7 show the progressivity results for the full possible range of pass-through

differences between formal and informal stores, from 100pp (baseline) to 0pp. Our main results hold qualitatively for any value in the $0 - 100$pp range: the average progressivity with full pass-through remains meaningful because of the absence of tax pass-through to home production, which represents 36% of informal consumption on average across countries (Figure A4). Moreover, home production has the steepest gradient in household income in the poorest countries (Figure A3), making uniform consumption taxes more progressive in those countries even under the unlikely assumption of 0pp differential pass-through.[17]

In practice, the pass-through to informal prices is likely to be significantly lower than that to formal prices, for at least three reasons. First, while informal retailers may pass on tax-costs to consumers due to purchases from formal suppliers (Appendix D.1), this is limited in practice since the VAT disincentivizes trade between VAT and non-VAT firms and creates segmentation between formal and informal supply chains (De Paula and Scheinkman, 2010; Gadenne et al., 2020). Indeed, in Mexico's retail census, we find that purchases from VAT-registered suppliers account for only 10% of traditional stores' input costs. Retail census data is rare, but in eight of our surveys, households report for each purchase if it is imported. Papers have argued that VAT levied on imported goods constitutes the most effective way of taxing informal firms' purchases from formal suppliers (Emran and Stiglitz, 2005; Keen, 2008). Figure A9 shows that imported goods account for 19% of the median household's purchases in traditional stores—a non-trivial share, but comparable to the 10% formal input-share estimated in Mexico.[18] Moreover, the prevalence of imported goods purchased in traditional stores rises with household income, suggesting that this import-VAT pass-through may itself be progressive. Second, due to their small size, many traditional retailers are legally exempt from remitting VAT (See Section 3.2). Third, households are unlikely to use formal inputs to produce at home, such that the pass-through of taxes

[17]The main progressivity results are also robust to using the estimated country-specific formal shares of modern and traditional stores from Section 3.2; see Table A2 and Figure A7.

[18]In Mexico's retail census only 8% of informal stores report VAT on inputs, which applies on average to 40% of their intermediate purchases. The informal retailers reporting positive VAT on inputs account for 25% of all informal sales, implying an overall formal input cost-share of 10% for informal retailers, likely an upper bound since home-production is not included. The Informal Economy Monitoring Study finds that 20% of informal retailers in 7 countries report purchases from formal suppliers (Mahadevia et al., 2014); amongst informal firms in 6 African cities, Bohme and Thiele (2014) estimates that 8% source any input from formal firms.

is negligible for home production. This discussion suggests that tax pass-through in informal stores may be limited, but as future research identifies pass-through in more settings, these estimates can be combined with our model and publicly available data to refine the progressivity impacts within the range of Figure 7.

6.3 Further Incidence Considerations

Our focus is on indirect taxes, but firms also pay direct taxes: traditional retailers often face presumptive taxes, while modern retailers pay corporate income taxes.[19] If these taxes are fully passed on to consumer prices, the ratio of additional tax burdens in modern versus traditional stores will be proportional to the ratio of corporate to presumptive tax rates. We convert presumptive rates on sales into equivalent rates on profits using data on small firms' profit margins in 20 developing countries (14 in sample). Figure A8 Panel A shows that the average ratio is large at 5.3: including direct taxes to our calculations would further raise progressivity. Panel A assumes full compliance with direct taxes. Alternatively, Panel B approximates the ratio of actual tax burdens with data on revenues collected from CIT and presumptive taxes: the average tax burden ratio is 7.2.

It is commonly assumed that consumers bear the incidence of indirect taxes, yet recent work finds that some incidence can be borne by firm owners via reduced profits and by workers via lower wages (Benzarti and Carloni, 2019).[20] Owners of modern stores are likely to belong to the top of the income distribution, but what about their workers? In 20 of our surveys' employment modules, we observe workers' industry and proxy for formal workers as those with a labor contract or social security contributions. In Figure A10, we show that formal retail workers, who are more likely to work in modern stores, have an income 32% higher than the average worker in the economy, in the average sample country. Thus, the progressivity impact is likely to remain positive in an expanded setting where modern store owners and workers bear some of the tax burden.[21]

[19] Presumptive taxes target smaller firms that do not have the capacity to maintain accounting records and might misreport profits. They typically tax sales instead of profits (Tanzi, 1987).

[20] Here we focus on formal stores, but note that informal stores could require consumers to pay taxes, but not remit them to the government, such that firm owner increase their profits.

[21] While modern and traditional stores appear segmented (section 4.2), their workers' income are close. This relates to the literature studying formality of both workers and firms (Ulyssea, 2018). An area for future research is how taxes jointly impact formalization choices of firms and workers, and the interaction between tax and labor market policies such as minimum wages.

7 Implications for Tax Policy and Inequality

This section studies the implications of our results for optimal commodity taxation through a model calibrated to our data. Section 7.1 assumes exogenous producer prices, as is common in the literature. Section 7.2 endogenizes firms' producer prices and formality decision. Section 7.3 calibrates the model.

7.1 Optimal Commodity Tax Model

We extend the Ramsey model of commodity taxation with heterogeneous households (Diamond, 1975) to a setting with informal varieties that cannot be taxed.

Households 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: $v = 0$ indicates a variety produced in the informal sector, which cannot be taxed, $v = 1$ a variety produced in the formal sector. Producer prices q_{jv} are exogenous. Consistent with our main formality assignment, consumer prices are given by $p_{j1} = q_{j1}(1 + t_j)$, where t_j is the tax on good j, and $p_{j0} = q_{j0}$. We write $v(p, y^i)$ 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 formal and informal varieties are substitutes. This introduces an additional efficiency cost of taxation compared to a model in which all varieties can be taxed: as the price of the formal variety rises, households substitute to informal varieties which leads to a tax revenue loss (see Appendix D.2). We further assume that demand elasticities are equal across households and that elasticities of substitution across goods taxed differently are equal to zero.[22]

Government preferences The government chooses the tax rates t_j to maximize:

$$W = \int_i G(v(p, y^i))di + \mu \sum_j t_j q_{j1} x_{j1} \tag{3}$$

where $x_{jv} = \int_i x^i_{jv}(p, y^i)$ is total consumption of the formal ($v = 1$) or informal

[22]This assumption is reasonable given that we only allow for differentiated tax rates across large product categories (e.g. food versus non-food), but can easily be relaxed.

($v = 0$) variety of good j and p is the vector of all consumer prices. 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 $\mu = \bar{g}$.[23]

Optimal uniform commodity taxation Consider a uniform tax on all goods, $t_j = t$ for all j. Writing $\tau = \frac{t}{1+t}$, welfare maximization yields:

$$\tau^* = \frac{\int_i (\bar{g} - g^i)\phi^i \frac{s_1^i}{s_1} di}{-\epsilon_1^D \bar{g}} \tag{4}$$

where $s_v = \sum_j \int_i s_{jv}^i di$ is the aggregate budget share spent on all formal ($v = 1$) or informal ($v = 0$) 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^D is the uncompensated price elasticity of demand for all formal varieties. Equation (4) shows that the optimal uniform rate increases with the co-variance between household income and the formal budget share: the more richer households spend on formal varieties relative to the poor, the more redistribution occurs from taxing only formal varieties. The presence of an informal sector thus raises the optimal uniform rate, absent efficiency considerations. Downward-sloping IECs indicate that the correlation between total formal consumption and income is higher than that between total consumption and income: taxing only formal varieties redistributes more than taxing all varieties uniformly.

The optimal rate decreases in the price elasticity of demand for formal varieties: the more households respond to formal price changes, the higher the efficiency cost of taxing only these varieties. Appendix D.2 shows that this effect increases with the elasticity of consumption substitution across varieties and the share of informal variety in total consumption. The more households are willing to substitute to informal varieties, the more demand for the formal variety responds to a rise in the tax and the higher the efficiency cost of taxing only formal varieties. As a result, efficiency considerations reduce the optimal rate on formal varieties relative to that on all varieties, more so the larger the informal sector.

[23] The latter assumption implies a government only taxes if it enables redistribution.

Optimal rate differentiation Consider now a government that sets different rates on goods. The optimal rate on good j is:

$$\tau_j^* = \frac{\int_i (\bar{g} - g^i)\phi^i \frac{s_{j1}^i}{s_{j1}} di}{-\epsilon_{j1}^D \bar{g}} \tag{5}$$

This expression shows that the optimal rate on good j is increasing in the covariance between household income and the budget share spent on the formal variety of good j. It is decreasing in the absolute value of the price elasticity of the formal variety, which itself is increasing with the informal budget share for the good and the elasticity of substitution between varieties.

7.2 Model extensions

Endogenous producer prices We relax our assumption of exogenous producer prices in Appendix D.3. To do this, we consider firms choosing which type of variety (formal or informal) to produce and how much to produce. Firms differ in their productivity and can only produce informally if they remain below a given size, following the literature modelling firms' formality choice (see De Paula and Scheinkman, 2010; Ulyssea, 2018). The informal sector size (which consists of all firms producing the informal variety), as well as formal and informal producer and consumer prices are thus endogenous to the distribution of firms' productivity and to the tax system.

We obtain the following expression for the optimal rate on formal varieties:

$$\tau^* = \frac{t^*}{1+t^*} \approx \frac{-\int_i (g^i - \bar{g})\phi^i \frac{s_1^i}{s_1} di + \int_i g^i \phi^i (\alpha_1^i \gamma_1 + \alpha_0^i \gamma_0 \frac{x_0 q_0}{x_1 q_1}) di}{-\bar{g}(\epsilon_1^D + \gamma_1(1 + \epsilon_1^D + \eta_1 s_1) + \gamma_0(\epsilon_{1,0}^D + \eta_1 s_1 \frac{x_0 q_0}{x_1 q_1}))} \tag{6}$$

where γ_1 is the pass-through of the tax on formal varieties t to the producer price of these varieties, γ_0 is the pass-through of this tax to the producer price of informal varieties, $\alpha_v^i = 1 - \frac{s_v^i}{s_v}$, $x_v q_v = \int_i x_{vi} q_v, \forall v = 0, 1$, η_1 is the income elasticity of demand for all formal varieties, $\epsilon_{1,0}^D$ is the elasticity of substitution between formal and informal varieties, and other terms are as defined above.

The first terms in the numerator and denominator of (6) are the same as our baseline expression (4). The second term in the numerator captures the effect of the change in producer prices on households' indirect utility and therefore on

the equity gains from taxing only formal varieties, which depends on how much they consume of each variety. The α_v^i terms are positive for households spending a lower budget share than the average on all formal ($v = 1$) or informal ($v = 0$) varieties, and negative otherwise. Overall, producer price responses tend to decrease the equity gains from taxing only formal varieties when IECs are downward-sloping. Intuitively, this is because higher taxes lead to lower formal producer prices ($\gamma_1 < 0$, so that the pass-through to formal consumer price is less than 100%, as observed above) and a smaller increase in formal consumer prices compared to our baseline model (where producer prices are fixed so the pass-through to formal consumer prices is 100%). This represents a relative gain for richer consumers who spend a higher budget share on formal varieties. A similar effect is obtained when higher taxes lead to higher informal prices because of consumers' substitution ($\gamma_0 > 0$, so that the passthrough to informal consumer price is positive), thereby penalizing poorer consumers.[24] Producer price responses reduce the equity gains from taxing formal varieties, pushing optimal rates down.

The second and third terms in the denominator capture the effect of producer price responses to changes in the tax rate on the tax base (total consumption of formal varieties), and thus on the efficiency cost of taxing formal varieties. Compared to the baseline model, these responses tend to reduce the efficiency cost of taxing only formal varieties by lowering the tax-induced rise in the formal (consumer) prices relative to the informal prices. This leads to a smaller drop in the formal tax base when taxes rise, pushing optimal rates up.[25] Overall, endogenizing producer prices lowers both the equity gains and the efficiency cost of taxing only formal varieties, leading to an ambiguous effect on optimal rates relative to expressions (4) and (5) above. See Appendix D.3 for more discussion and for expressions for the optimal rates on the formal variety of each good j.

[24] The effect of higher taxes on informal prices is a priori ambiguous: demand side responses push prices up as consumers substitute to informal varieties, but supply side responses push prices down as firms join the informal sector in response to higher taxes. In practice, the evidence from the Mexican reform in section 6.1 suggests that demand responses tend to dominate, and the pass-through of taxes to informal prices is positive ($\gamma_0 > 0$).

[25] A drop in formal producer prices ($\gamma_1 < 0$) has a priori ambiguous effects: it reduces the tax base (increasing efficiency costs), but raises demand via price effects (decreasing efficiency costs); the latter dominates as long as the price elasticity is higher than 1. A rise in informal prices ($\gamma_0 > 0$) unambiguously lowers the efficiency cost by increasing demand for formal varieties.

Endogenous enforcement threshold As explained above, governments can also affect the informal sector size by choosing the threshold below which firms can operate informally.[26] We use this model to study the welfare properties of such a tax enforcement policy in Appendix D.4. We find a clear efficiency-equity trade-off of changing the size threshold above which firms cannot operate informally when IECs are downward sloping. Raising the threshold leads to an efficiency loss (by decreasing the size of the formal sector) and to an equity gain, because it increases the price of formal varieties relative to informal varieties.

Personal Income Taxes A central result in public finance is that redistribution is better achieved via direct rather than indirect taxes (Atkinson and Stiglitz, 1976). However, this result assumes perfectly enforceable income taxes. This is at odds with reality in developing countries where the prevalence of self-employment constrains governments' ability to expand the tax base to large segments of the active workforce (Jensen, 2022). Indirect taxes serve a redistributive role as soon as income tax evasion is considered (Huang and Rios, 2016). In Appendix D.5 we incorporate to the model a personal income tax (PIT) characterized by an exemption threshold and a top marginal tax rate. The PIT affects optimal consumption taxes in two ways. It decreases the welfare gains from taxing richer households via taxes on goods with steep Engel curves (as these households are already taxed by PIT). It also lowers rich households' consumption of these goods, which decreases their tagging potential. Both effects reduce optimal commodity taxes.

7.3 Calibration results

Calibration parameters Table A4 summarizes our choices of parameters to calibrate the optimal rates defined in equations (4) and (5). We use our data to calibrate the budget shares for each good, variety and country, and the slopes of the Engel curves to calibrate income elasticities.[27] 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

[26] Governments can do this either directly, by exempting small firms from taxation, or indirectly, by allocating enforcement efforts to firms of different sizes.

[27] We estimate Engel curves' slopes using a specification with all controls but good fixed effects (Table 2). Income elasticities are thus not confounded by changes in demand due to household characteristics (demographics, location) that correlate with income, see Table A4 for more details.

and Fally (2017) and Atkin et al. (2018b); we use 1.5 as our baseline value for all goods. 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 sample countries. This matches the statutory consumption tax rates often set in practice. Demand parameters and government preferences are the same in all countries so that cross-country variation in optimal rates is driven by differences in consumption patterns. For the endogenous producer price extension we use Mexico's reform estimates of the tax pass-through to formal and informal consumer prices, to obtain the parameters $\gamma_1 = -0.17$ and $\gamma_0 = 0.16$ which capture the tax elasticity of producer prices.[28] For the PIT extension we use data from Jensen (2022) on the size of countries PIT base and assign to all the top marginal rate observed in our sample of 50%.[29]

Calibrated tax rates Figure 8 presents our calibration results as a function of countries' per capita income. Panel (a) shows that optimal rates are lower in low-income (17%) than in middle-income countries (19%). This is because the efficiency gains due to the shrinking share of formal consumption (Figure 2) push optimal rates up; this effect is stronger than the falling progressivity of taxing formal consumption (Figure 5), which pushes optimal rates down.[30]

Figure 8b plots the ratio of the optimal food to non-food rates. A lower value indicates a higher optimal subsidy on food; a value above one indicates a higher optimal rate on food than on non-food. We find that rates on food are 20% lower than on non-food in low-income countries and 40% lower in middle-income countries. This effect is driven by the progressivity patterns across goods (Figure 5): once informal consumption is accounted for, the tagging potential of exempting food is limited. This is especially true in poor countries, where food subsidies accrue disproportionately to richer households who consume most formal food.

We perform several robustness checks. First, optimal food subsidies remain small for all plausible values of the cross-variety elasticity of substitution (Fig-

[28] Table A4 explains our derivation of the model's parameters based on Mexico's VAT reform.

[29] This conservative choice overstates the redistribution achieved by the PIT.

[30] Figure A11 shows that uniform rates slightly fall with development if we assume very low efficiency costs, but rises for a range of plausible values of the elasticity of substitution.

ure A11). Second, allowing for endogenous producer prices leads to a moderate increase in uniform tax rates, from 18% to 20.4% on average (Figure A12). As expected, endogenizing producer prices reduces both the equity gains and the efficiency cost of taxing only formal varieties; quantitatively the latter effect slightly dominates. Optimal rate differentiation results are similarly hardly affected. Third, allowing for stylised personal income tax (PIT) reduces uniform consumption rates, as expected - from 18% to 16% on average (Figure A13) - but the drop is limited by the narrow income tax bases of these countries.

Inequality Our metric for the inequality effect of calibrated consumption taxes is the percent change in Gini from the pre-tax to the net-of-tax expenditure distribution. With a uniform tax rate, the inequality effect depends on the level of the rate, the progressivity of taxing formal consumption and the formal consumption share. For differentiated rates, the progressivity gains from taxing formal non-food differently from food, and the size of their respective tax bases also matter.

Figure 8c shows that the average Gini reduction achieved with uniform rates is sizeable (1.9%). Effects rise with development, from 1% in the poorest countries to 3% in upper-middle income countries, due to their higher tax rates and wider tax bases, and despite the reduced progressivity of taxing formal consumption as countries get richer. Figure 8d shows that the marginal inequality gains from differentiating rates is limited: on average, the Gini gains rise from 1.9% to 2.6%. The redistribution potential of consumption taxes is thus mostly due to distributional differences in informal consumption. The marginal Gini reduction from rate differentiation grows over development due to the higher progressivity of lower rates on formal food (Figure 5) and further rate differentiation (Figure 8).[31]

Figure A15 shows inequality effects for the full range of pass-through in formal and informal stores, including our Mexico estimates (Section 6). Informal price pass-through affects inequality via two countervailing forces: the fall in progressivity directly lowers the Gini reduction, but augments the tax base which amplifies the Gini reduction.[32] These two forces cancel each other out in low-income

[31] In an extension we simulate optimal rate differentiation across the 12 two-digit COICOP categories: the dispersion in tax rates rises as countries get richer, in line with our main results. The average inequality reduction achieved is 20% higher, but almost null in lower-income countries.

[32] For example, allowing for a 50% pass-through to informal market consumption increases the base by half the informal expenditure share minus the home production share

countries, resulting in stable effects for the full range of pass-through rates. In middle-income countries, informal price pass-through weakens the equity gains from uniform taxes. With full pass-through, uniform rates no longer redistribute in richer countries and inequality reductions from rate differentiation increase. Finally, adding a stylised PIT only marginally affects results (Figure A13).[33]

To assess magnitudes, we compare our results to the Commitment to Equity (CEQ) studies in 25 developing countries (Lustig, 2018). CEQ evaluates actual rather than optimal policies and rarely accounts for informal consumption. Yet, CEQ findings reflect the consensus view on the limited redistribution of consumption taxes: their average inequality reduction is 0.6%, three times less than our average estimates. Our results are more comparable to the Gini reduction achieved by actual income taxes and social security in CEQ (2.6% on average).

8 Conclusion

In this paper, we harmonize expenditure surveys from 32 developing countries which contain the store type for each transaction. We allocate store types to the informal or formal sector using a robust assignment rule, which allows to measure each household's informal consumption. 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 can lower inequality by 2-3%, as much as actual personal income taxes in those countries. Our results have sharp implications for the widespread policy of reduced rates on necessity goods, which has limited redistributive potential once informal consumption is accounted for. Since rate differentiation leads to more tax evasion and administrative costs (Ebrill and Keen, 2001), this cautions against extensively deploying rate differentiation, particularly in poorer countries.

Tax administrations often focus enforcement on large firms (Basri et al., 2019) and exempt firms below a threshold (Keen and Mintz, 2004). Going forward, the growth of digital technologies may lower enforcement and compliance costs and make it possible to bring smaller firms into the tax net. Our results do not imply

[33] Accounting for PIT implies that the average Gini reduction from consumption taxes falls from 1.9% to 1.6% with a uniform rate, and from 2.6% to 2.1% with differentiated rates (Table A5). The table also reports inequality effect from changing the cross-variety elasticity; country-specific formality shares instead of our baseline formality assignment; and allowing for savings.

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 costs.

References

Akerlof, G. (1978): "The Economics of Tagging," *American Economic Review*, 68.

Allcott, H., B. B. Lockwood, and D. Taubinsky (2019): "Regressive Sin Taxes, with an Application to the Optimal Soda Tax," *Quarterly Journal of Economics*, 134, 1557–1626.

Almås, I. (2012): "International Income Inequality: Measuring PPP Bias by Estimating Engel Curves for Food," *American Economic Review*, 102, 1093–1117.

Alvaredo, F. and L. Gasparini (2015): *Recent Trends in Inequality and Poverty in Developing Countries*, vol. 2 of *Handbook of Income Distribution*, Elsevier.

Anker, R. et al. (2011): "Engel's Law around the World 150 Years Later," *Political Economy Research Institute Working Paper*, No. 247.

Atkin, D., B. Faber, T. Fally, and M. Gonzalez-Navarro (2018a): "A New Engel on the Gains from Trade," *NBER Working Paper*, No. 26890.

Atkin, D., B. Faber, and M. Gonzalez-Navarro (2018b): "Retail Globalization and Household Welfare," *Journal of Political Economy*, 126, 1–73.

Atkinson, A. and J. Stiglitz (1976): "The Design of Tax Structure: Direct versus Indirect Taxation," *Journal of Public Economics*, 6.

Basri, M. C., M. Felix, R. Hanna, and B. A. Olken (2019): "Tax Administration vs. Tax Rates," *NBER WP*, No. 26150.

Benzarti, Y. and D. Carloni (2019): "Who Really Benefits from Consumption Tax Cuts? Evidence from VAT Reform in France," *AEJ: Economic Policy*, 11.

Benzarti, Y., D. Carloni, J. Harju, and T. Kosonen (2020): "What Goes Up May Not Come Down: Asymmetric Incidence of Value-Added Taxes," *Journal of Political Economy*, 128, 4438–4474.

Besley, T. and T. Persson (2013): "Chapter 2 - Taxation and Development," in *handbook of public economics, vol. 5*, ed. by M. F. Alan J. Auerbach, Raj Chetty and E. Saez, Elsevier, vol. 5 of *Handbook of Public Economics*, 51 – 110.

Best, M., A. Brockmeyer, H. Kleven, J. Spinnewijn, and M. Waseem (2015): "Production vs Revenue Efficiency With Limited Tax Capacity: Theory and Evidence From Pakistan," *Journal of Political Economy*, 123(6), 1311–1355.

Bohme, M. and R. Thiele (2014): "Informal-Formal Linkages in Urban West Africa," *European Journal of Development Research*, 26, 473–80.

Bronnenberg, B. J. and P. B. Ellickson (2015): "Adolescence and the Path to Maturity in Global Retail," *Journal of Economic Perspectives*, 29, 113–34.

Casaburi, L. and U. Troiano (2015): " Ghost-House Busters: Electoral Responses to an Anti–Tax Evasion Program," *Quarterly Journal of Economics*, 131, 273–314.

De Paula, A. and J. A. Scheinkman (2010): "Value-Added Taxes, Chain Effects, and Informality," *American Economic Journal: Macroeconomics*, 2, 195–221.
De Simone, R. (2020): "Tax Enforcement as Corporate Governance," *WP, LBS*.
Deaton, A. (1997): *The Analysis of Household Surveys*, The World Bank.
Deaton, A., K. Parikh, and S. Subramanian (1994): "Food Demand Pattern and Pricing Policy in Maharashtra," *Sarvekshana*, 17, 11–34.
Deaton, A. and C. Paxson (1998): "Economies of Scale, Household Size, and the Demand for Food," *Journal of Political Economy*, 106, 897–930.
DellaVigna, S. and M. Gentzkow (2019): "Uniform Pricing in U.S. Retail Chains," *Quarterly Journal of Economics*, 134.
Demirguc-Kunt, A., L. Klapper, D. Singer, S. Ansar, and J. Hess (2018): *The Global Findex Database 2017*, The World Bank.
Diamond, P. A. (1975): "A Many-Person Ramsey Tax Rule," *Journal of Public Economics*, 4, 335–342.
Ebrill, L. P. and M. Keen (2001): *Modern VAT*, International Monetary Fund.
Emran, M. S. and J. E. Stiglitz (2005): "On selective indirect tax reform in developing countries," *Journal of Public Economics*, 89, 599–623.
Faber, B. and T. Fally (2017): "Firm Heterogeneity in Consumption Baskets: Evidence from Home and Store Scanner Data," *NBER Working Paper*, No. 23101.
Gadenne, L. (2017): "Tax Me, but Spend Wisely? Sources of Public Finance and Government Accountability," *American Economic Journal: Applied Economics*, 9.
Gadenne, L., T. Nandi, and R. Rathelot (2020): "Taxation and Supplier Networks: Evidence from India," *CEPR Discussion Paper*, No. DP13971.
Gemmell, N. and O. Morrissey (2005): "Distribution and Poverty Impacts of Tax Reform in Developing Countries," *Development Policy Review*, 23, 131–144.
Gerard, F. and G. Gonzaga (2016): "Informal Labor and the Efficiency Cost of Social Programs," *NBER Working Paper*, No. 22608.
Harju, J., T. Kosonen, and O. N. Skans (2018): "Firm types, price-setting strategies, and consumption-tax incidence," *Journal of Public Economics*, 165, 48–72.
Harris, T., D. Phillips, R. Warwick, M. Goldman, J. Jellema, K. Goraus, and G. Inchauste (2018): "Redistribution via VAT and Cash Transfers: An Assessment in Four Low and Middle Income Countries," *IFS Working Paper*, W18/11.
Huang, J. and J. Rios (2016): "Optimal Tax Mix with Income Tax Non-Compliance," *Journal of Public Economics*, 144, 52–63.
Humphrey, J. (2007): "The Supermarket Revolution in Developing Countries," *Journal of Economic Geography*, 7, 433–450.
Jaravel, X. (2019): "The Unequal Gains from Product Innovations: Evidence from the U.S. Retail Sector," *The Quarterly Journal of Economics*, 134, 715–783.
Jenkins, G. P., H. P. Jenkins, and C. Y. Kuo (2006): "Is the Value Added Tax Naturally Progressive?" *Working Paper, Queen's University*, No. 1059.
Jensen, A. (2022): "Employment Structure and the Rise of the Modern Tax system," *American Economic Review*, 112, 213–34.

Keen, M. (2008): "VAT, tariffs, and withholding: Border taxes and informality in developing countries," *Journal of Public Economics*, 92, 1892–1906.

Keen, M. and J. Mintz (2004): "The Optimal Threshold for a Value-Added Tax," *Journal of Public Economics*, 88, 559 – 576.

Kleven, H. J. (2014): "How Can Scandinavians Tax So Much?" *Journal of Economic Perspectives*, 28, 77–98.

La Porta, R. and A. Shleifer (2014): "Informality and Development," *Journal of Economic Perspectives*, 28, 109–26.

Lagakos, D. (2016): "Explaining Cross-Country Productivity Differences in Retail Trade," *Journal of Political Economy*, 124, 579–620.

Londono-Velez, J. and J. Avila-Mahecha (2021): "Enforcing Wealth Taxes in the Developing World: Quasi-Experimental Evidence from Colombia," *American Economic Review: Insights*, 3, 100–128.

Lustig, N. (2018): *Commitment to Equity Handbook: Estimating the Impact of Fiscal Policy on Inequality and Poverty*, Brookings Institution Press.

Mahadevia, D., S. Vyas, and A. Mishra (2014): "Street Vendors in Ahmedabad, India," *Informal Economic Monitoring Study Country Series*.

Marion, J. and E. Muehlegger (2011): "Fuel tax incidence and supply conditions," *Journal of Public Economics*, 95, 1202–1212.

Mariscal, R. and A. Werner (2018): "The Price and Welfare Effects of the Value-Added Tax: Evidence from Mexico," *IMF Working Papers*, 18.

Nakamura, E. and J. Steinsson (2008): "Five Facts About Prices: A Reevaluation of Menu Cost Models," *Quarterly Journal of Economics*, 123.

Naritomi, J. (2019): "Consumers as Tax Auditors," *American Economic Review*, 109.

Pomeranz, D. (2015): "No Taxation without Information: Deterrence and Self-Enforcement in the Value Added Tax," *American Economic Review*, 105, 2539–69.

Saez, E. and S. Santcheva (2016): "Generalized Social Marginal Welfare Weights for Optimal Tax Theory," *American Economic Review*, 106, 24–45.

Sah, R. K. (1983): "How Much Redistribution is Possible through Commodity Taxes?" *Journal of Public Economics*, 20, 89–101.

Tanzi, V. (1987): "Presumptive Income Taxation: Adminstrative, Efficiency, and Equity Aspects," *IMF Working Paper Series*, 87.

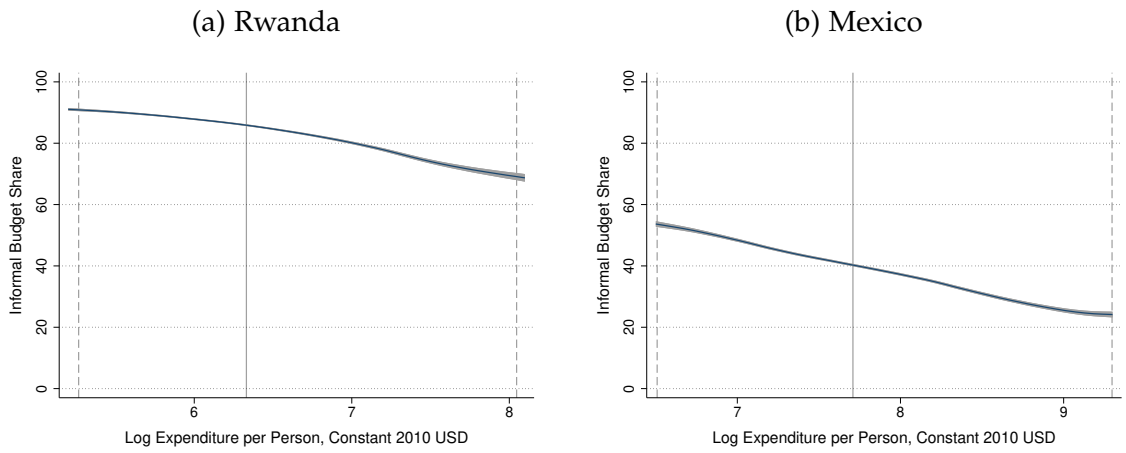
Ulyssea, G. (2018): "Firms, Informality, and Development: Theory and Evidence from Brazil," *American Economic Review*, 108, 2015–47.

Warren, N. (2008): "Review of Studies on Distributional Impact of Consumption Taxes in OECD Countries," *OECD Working Papers*, No. 64.

Waseem, M. (2020): "Overclaimed Refunds, Undeclared Sales, and Invoice Mills," *CESifo Working Paper*, No. 8231.

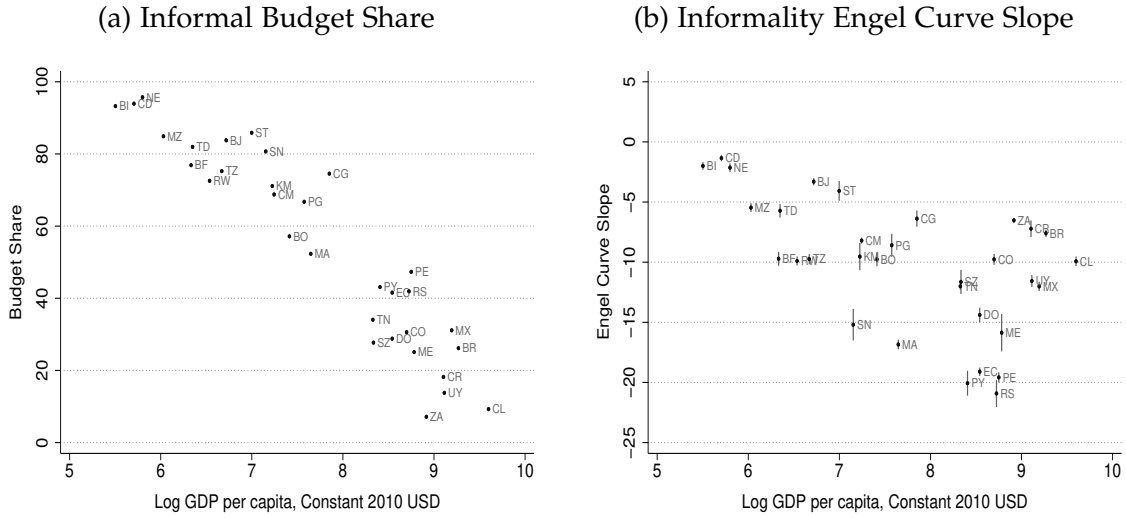
Weigel, J. (2019): "The Participation Dividend of Taxation," *Quarterly Journal of Economics*, 135.

Figure 1: Selected Informality Engel Curves



Notes: These figures show the local polynomial fit of the Informality Engel Curve (IEC) in Rwanda and Mexico, constructed from household level data. The informal budget share is on the vertical axis. Log per person total expenditure is on the horizontal axis. 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. More details in Section 4.1. See the online appendix for each country's IEC.

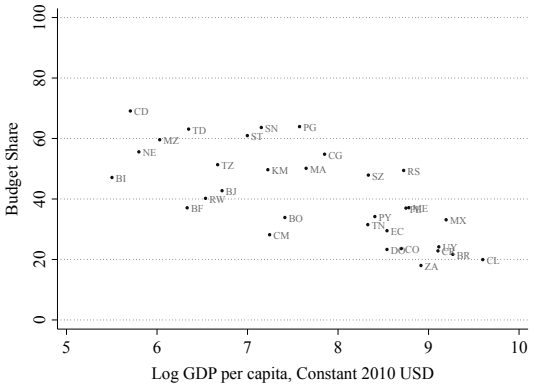
Figure 2: Informal Expenditure Across Countries



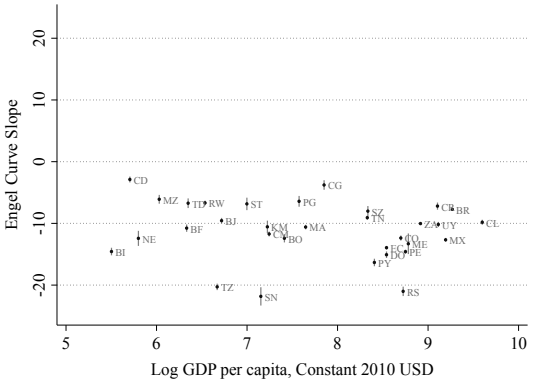
Notes: Figure 2a plots the aggregate informal budget share against log GDP per capita for each country. Figure 2b shows the slope of the informality Engel curves against log per capita GDP. The bars denote the 95% confidence interval of the slope coefficient. More details in Section 4.1.

Figure 3: Expenditure on Different Goods Across Countries

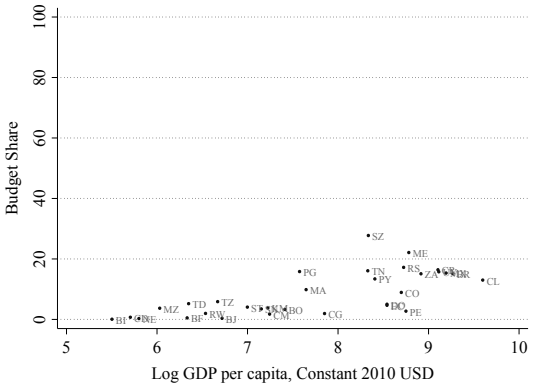
(a) Food Budget Share



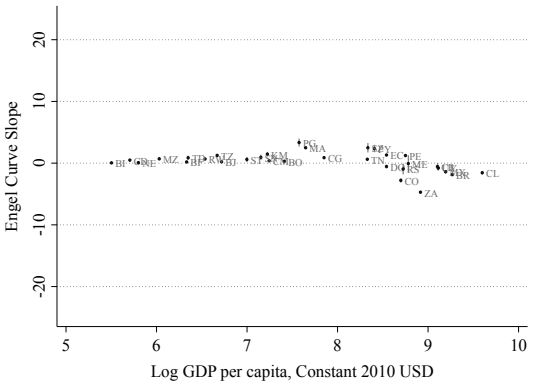
(b) Food Engel Curve Slope



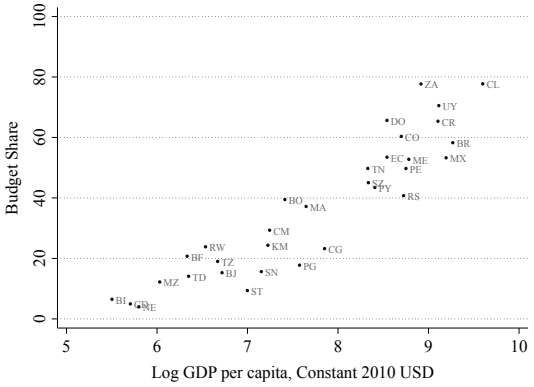
(c) Formal Food Budget Share



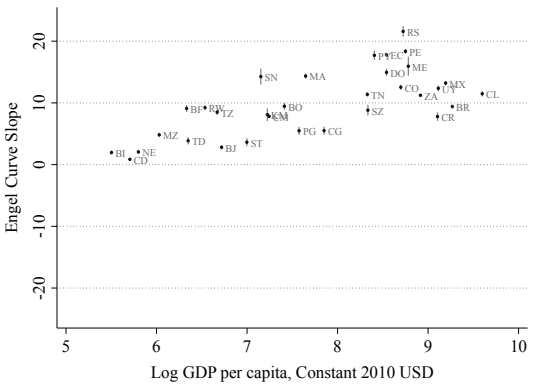
(d) Formal Food Engel Curve Slope



(e) Formal Non-Food Budget Share

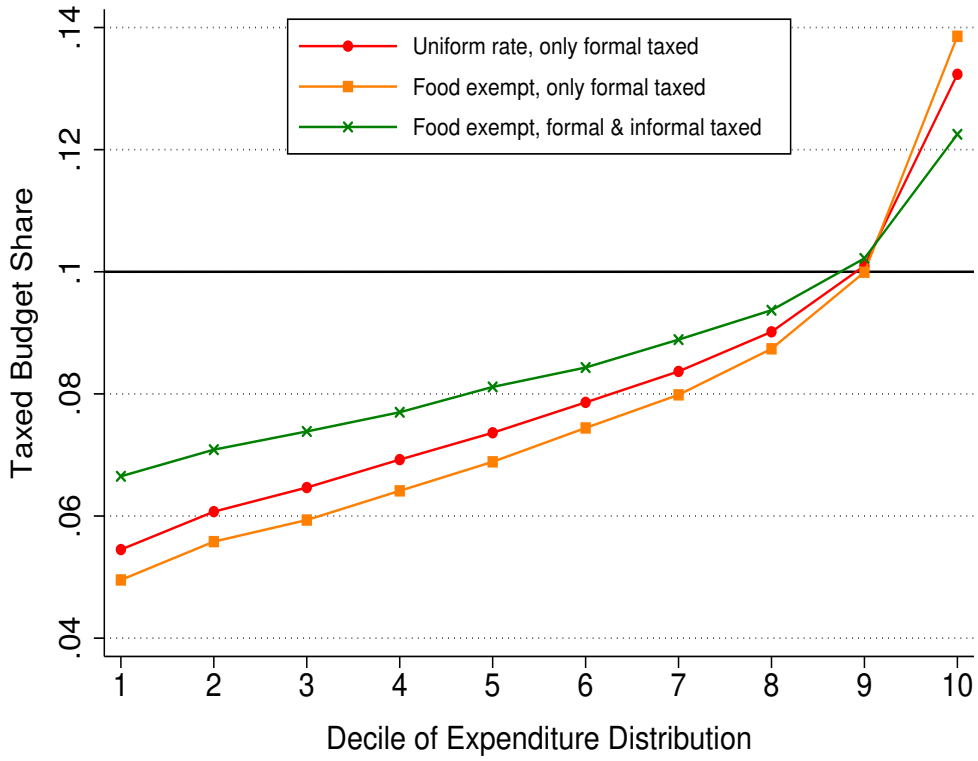


(f) Formal Non-Food Engel Curve Slope



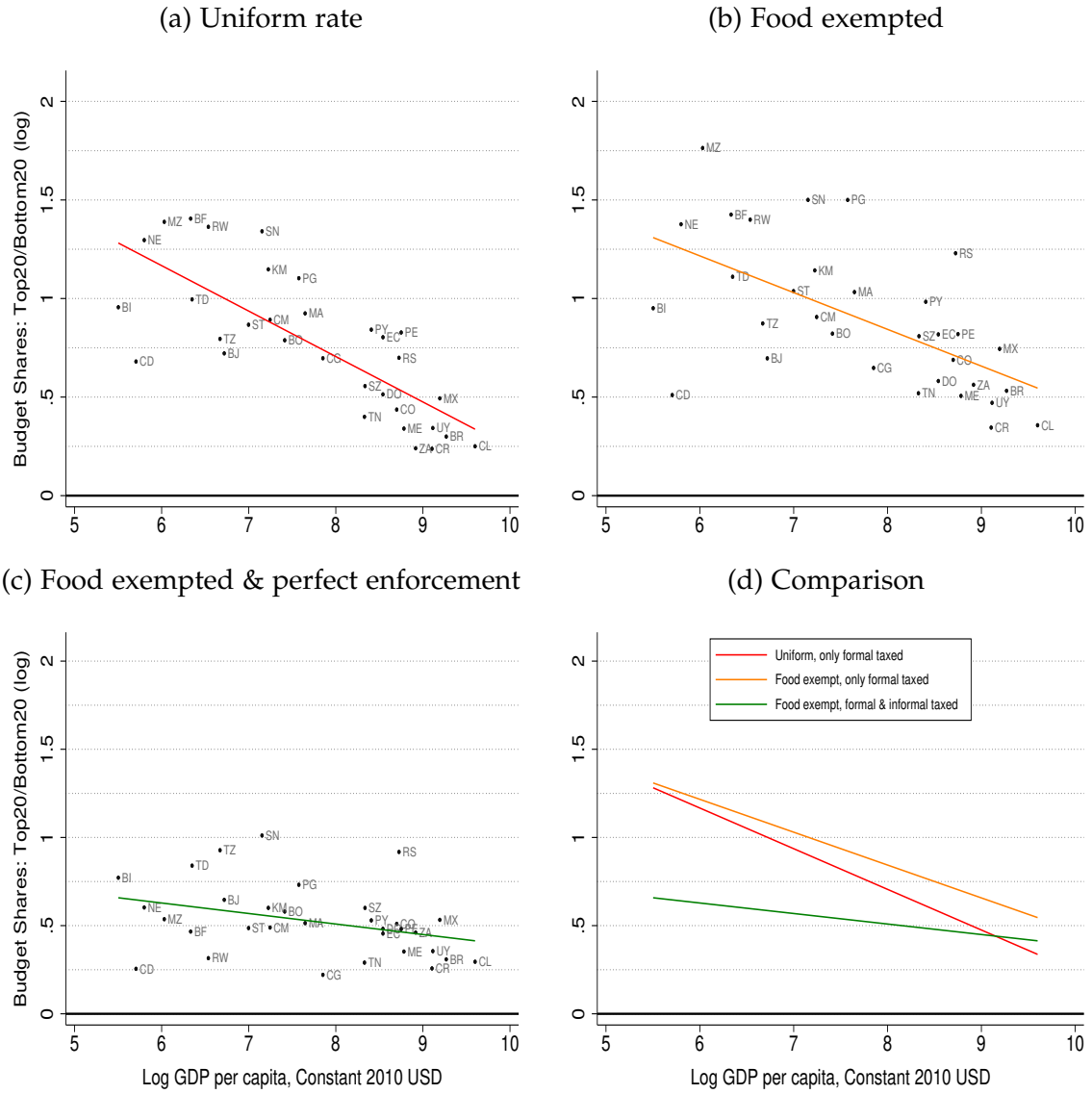
Notes: This figure shows the aggregate budgets shares (left panels) and Engel curves slopes (right panels) against log GDP per capita for three types of consumption goods: food (panels a-b), formal food (panels c-d), and formal non-food (panels e-f). More details in Section 4.3.

Figure 4: Progressivity of Tax Policy Scenarios (Average Across Countries)



Notes: This figure plots the share of expenditures paid in taxes (effective tax rates) by expenditure decile, for the three tax policy 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% of total consumption in taxes and assumes that households do not respond to taxes by changing their consumption choices (mechanical simulations). The black horizontal line at 10% is thus the effective tax rate when all consumption—formal and informal—is taxable at a uniform rate. The red circled line corresponds to a scenario where a uniform tax is levied on all goods consumed from formal retailers. The orange squared line corresponds to a scenario where food is zero-rated and only formal non-food consumption is taxed. The difference between the orange squared line and the red circled line captures the marginal progressivity gains of tax exempting food when informal consumption is accounted for. The green crossed line corresponds to the scenario with a zero rate on food goods, but with taxes paid on consumption in both formal and informal stores. The difference between the green crossed line and the horizontal black line captures the marginal progressivity gain of exempting food in the unrealistic perfect tax enforcement scenario.

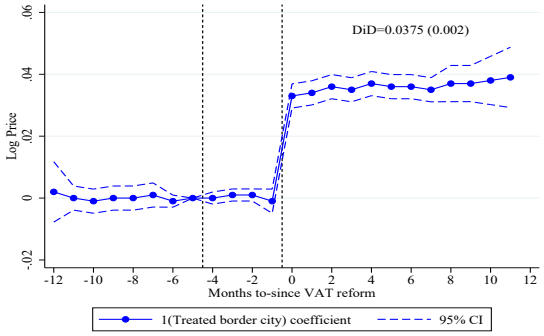
Figure 5: Progressivity of Taxing Different Goods across Countries



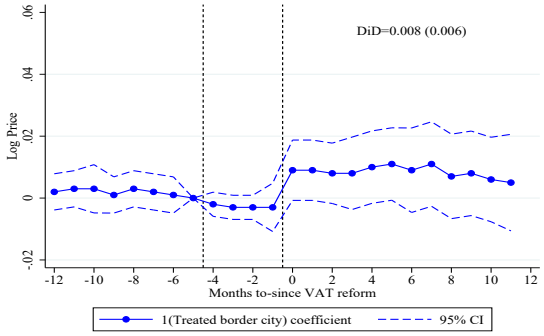
Notes: This figure plots the log of the ratio of the budget shares spent on a good by the richest quintile of households relative to that of the poorest quintile, against the country's log per capita GDP. The log transformation implies that a positive value of the budget share ratio corresponds to a progressive tax base, a negative value to a regressive one and a zero value to a neutral tax base (i.e. the budget share of rich and poor are equal). In each panel, the slope corresponds to the best linear fit across countries. Each panel corresponds to a tax policy scenario described in section 5.1: scenario 1 (uniform tax rate on goods, only formal retailers are taxed) in panel (a), scenario 2 (food products are exempted, only formal retailers are taxed) in panel (b) and scenario 3 (food products are exempted but all non food products are taxed regardless of place of purchase) in panel (c). Panel (d) shows the linear fit lines of the first three panels to directly compare the progressivity of taxing different bases. See Section 5.2 for more details.

Figure 6: Pass-through by Store Type: Evidence from Mexican VAT Reform

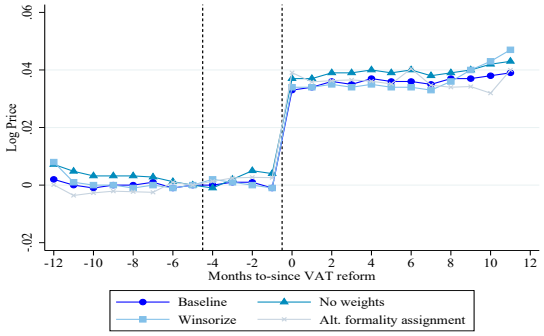
(a) Pass-through in Modern Stores



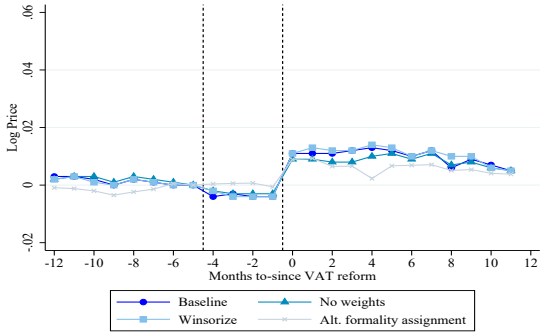
(b) Pass-through in Traditional Stores



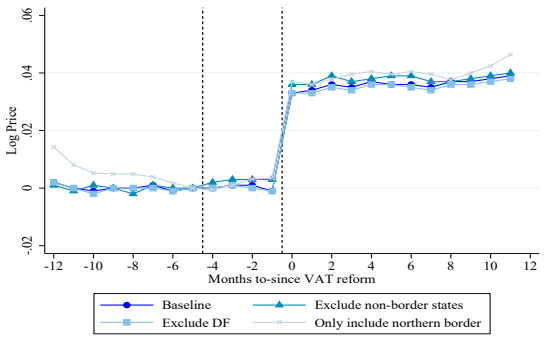
(c) Robustness: Measurement



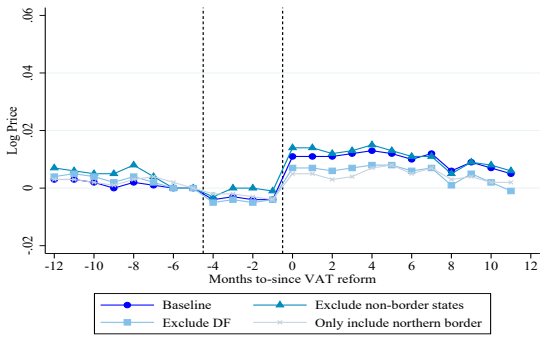
(d) Robustness: Measurement



(e) Robustness: Spatial assignment



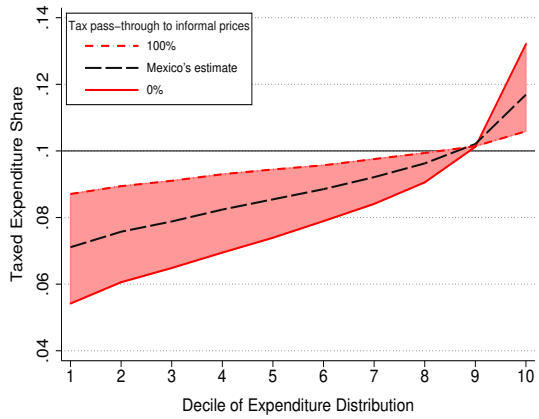
(f) Robustness: Spatial assignment



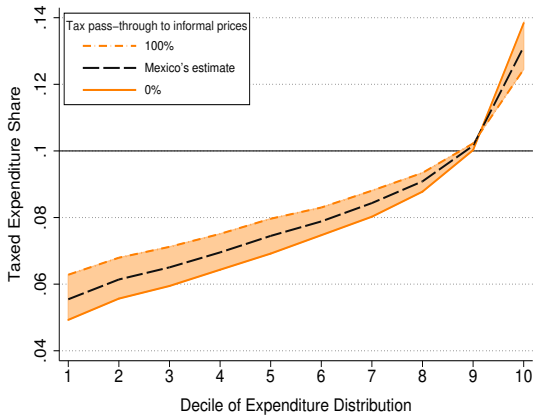
Notes: This figure shows the pass-through of taxes to consumer prices in modern and traditional stores (left and right panels, respectively). In the top panels, we show the difference in differences regression coefficients β_t from estimating Equation 2. The dashed curves mark the 95% confidence interval; standard errors are clustered at the product-location level. The dashed vertical lines denote the date when the reform was announced (August 2013) and its implementation date (January 2014), when the VAT rate increased from 11% to 16% in border areas. Months are counted relative to the implementation date. The middle panels implement three checks: removing product-location weights; winsorizing the top and bottom 5% of prices; and, using VAT formality status rather than store type. The bottom panels implement three further checks: excluding non-border states from the control; excluding Mexico City; and, excluding all non-northern border states. See Section 6.1 for details.

Figure 7: Tax Progressivity with Pass-Through to Informal Prices

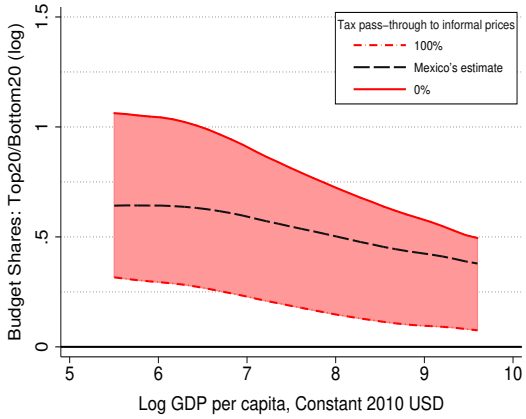
(a) Avg Across Countries: Uniform Rate



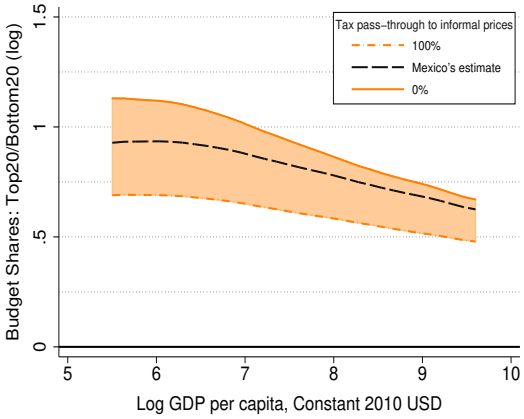
(b) Avg Across Countries: Food Exempted



(c) Cross-country: Uniform Rate



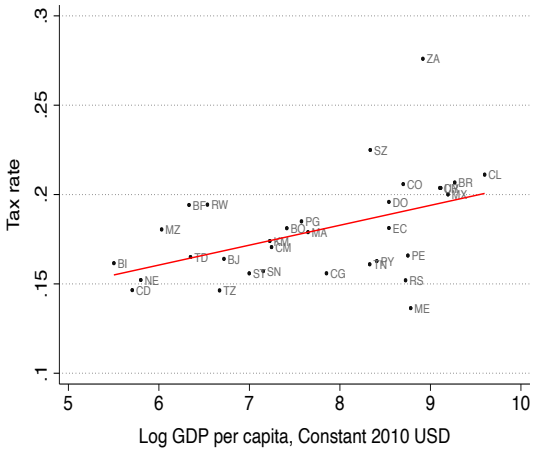
(d) Cross-country: Food Exempted



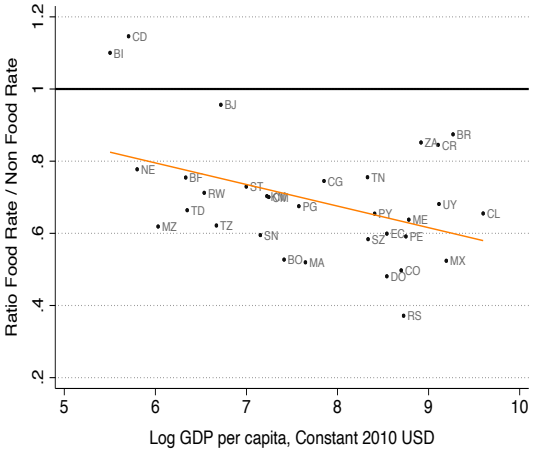
Notes: These figures shows how tax pass-through on informal sector prices impacts consumption taxes progressivity: taking the average across the 32 sample countries (panels 7a and 7b), and fitting polynomials across countries at different per capita GDP (panels 7c and 7d. The red scenario corresponds to the case where a uniform tax rate is levied on all formal consumption. The orange scenario corresponds to the case where food is exempted, and only formal non-food products are taxed (see section 5). In each scenario the government raises 10% of consumption in taxes and there are no behavioral responses. The solid colored line corresponds to our baseline assumption of 0 tax pass-through to informal stores' prices and full pass-through to formal stores. The dotted black line applies the pass-through estimate from Mexico's reform (pass-through difference between formal and informal stores of 59pp) to all countries. The colored dotted line corresponds to the case where pass-through is 100% in all stores, but for home production. The top panels plot the effective tax rate at each decile of the income distribution, on average across countries. See Section 6.2.

Figure 8: Calibration Results with Baseline Incidence Assumptions

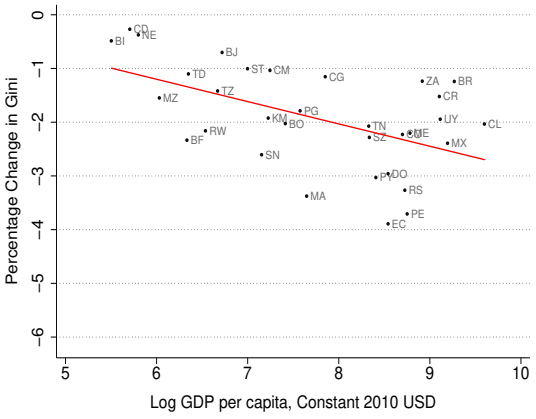
(a) Optimal Uniform Rates



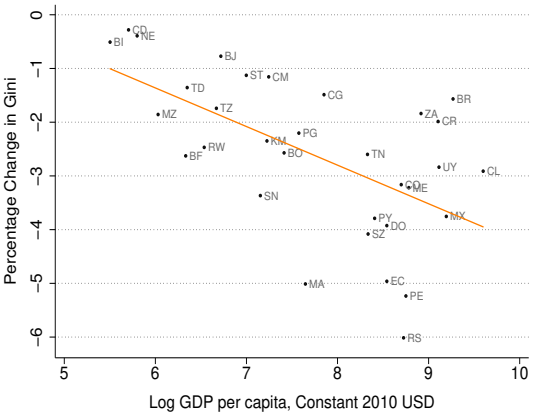
(b) Optimal Rate Differentiation



(c) Inequality Effect: Uniform Rates



(d) Inequality Effect: Rate Differentiation



Notes: Panel (a) plots the optimal uniform tax rate as a function of a country's log GDP per capita, calibrated based on equation (4). Panel (b) plots the optimal level of rate differentiation between food and non-food products (measured as the ratio of optimal rate on food to optimal rate on non-food) as a function of a country's log GDP per capita. Panels (c) and (d) plot the percentage change in the Gini coefficient obtained from applying optimal commodity tax rates on all formal consumption against a country's log GDP per capita. The Gini coefficients are measured using percentiles of the pre-tax and post-tax expenditure distributions. The lines correspond to the best linear fits. The optimal tax rates are calibrated based on equations (4) and (5). All calibration parameters take the baseline values specified in Table A4, see section 7 for more details.

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

Notes: This table provides information on the surveys used in the 32 countries in our sample. Code refers to the country-code acronym which we use in figures. The original name of the survey is provided. GDP per capita is in PPP USD in the year of the survey, obtained from the World Bank Development Indicators. 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. More details in Section 2.1.

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

Notes: This table shows the (negative of the) average slope of the Informality Engel Curves across countries for different specifications. 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. The average of lower and upper bound of 95% confidence intervals in brackets, calculates using 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. More details in Section 4.2.

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