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Abstract

The Value-Added Tax (VAT) is the most prevalent consumption tax globally, yet it is frequently deemed highly regressive. To address this, we propose a Personalized VAT (PVAT) devised in conjunction with a distributional policy. We aim to achieve three objectives: increase revenue collection, achieve progressivity, and disrupt the intergenerational dependency of low-income households. We use Mexico as a case study, showing that eliminating all special VAT regimes and standardizing the rate at 16% could contribute an additional 2.2% of GDP to fiscal revenues. However, such a reform could have severe negative welfare impacts on the poor. To tackle this dilemma, we propose several PVAT scenarios. Our results indicate that a PVAT could be fiscally neutral or even increase revenues by up to 0.83% of GDP, while benefiting the lowest-income households. Lastly, we analyze the general equilibrium effects of a PVAT and various distributional policies, including lump-sum and capital transfers. For this purpose, we employ an overlapping generations model calibrated for Mexico. Our simulations reveal welfare enhancing and output growth results through a PVAT policy that includes capital transfers, thereby presenting a viable strategy for breaking intergenerational dependency.

JEL classifications: E62, H21, O11, O12

Keywords: Value-added tax, Personalized value-added Tax, Tax reform, Overlapping generations, Inci-dence.

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1 Introduction

Value-Added Taxes (VATs) and their economic implications have been the subject of comprehensive theoretical and policy-based investigations. One key theoretical finding is that consumption taxes do not inherently facilitate income redistribution from wealthy to poor households. This stems from the fact that VATs, by nature, are regressive, disproportionately burdening lower-income households more than their wealthier counterparts. This observation often incites strong political opposition to end consumption taxes or proposals for rate increases. Despite this, the issue of VAT progressivity continues to surface in policy debates. Despite their regressive nature, VATs are frequently utilized by countries, both developed and emerging, as a tool to pursue social objectives, particularly in cases where more effective transfer mechanisms are lacking. This approach often results in substantial political resistance to final consumption taxes or reforms aiming to raise rates. Yet, to achieve income redistribution, the revenue collected from these VAT schemes must be redirected towards less affluent households.

Comprehending how VAT design becomes regressive necessitates an investigation into tax incidence, as different households experience varying exposure to the purchases of necessities. Several countries have either implemented or are considering the application of a zero-rate VAT on certain goods, or their exemption from the tax altogether. This approach is more widespread than one might think. Almost all countries apply preferential rates to some goods and services, thereby making them either "zero-rated" or simply subjected to a lower rate. For a "zero-rated good," the government refrains from taxing its retail sale but allows credits for the VAT paid on inputs, effectively reducing the good's price. Zero-rated VATs are commonly implemented to alleviate the tax burden on low-income households by targeting essential goods like food, utilities, or prescription drugs. As a matter of fact, 18 OECD countries apply a zero rate to certain goods, and 24 apply at least one non-zero reduced rate to a subset of goods.

However, zero-rated VATs or rate reductions are not without complications. If there is no accurate identification of the specific households set to benefit from these measures, VATs can lead to unintended consequences. For instance, high-income households often exploit zero-rated VATs on food due to significant price effects, leading to higher consumption levels. Consequently, fiscal policymakers find themselves navigating between two opposing arguments. On one hand, a generalized VAT appears to be progressive in absolute terms, as wealthier households will spend, and therefore pay more VAT, than poorer households. On the other hand, a general VAT is regressive in relative terms, as lower-income households dedicate a larger proportion of their income to VAT payments than their wealthier counterparts. This increased burden on lower-income households becomes especially problematic in societies characterized by low intergenerational mobility.

In this paper, we introduce a concept we term the Personalized VAT with capital transfers (PVAT-K), designed to enhance relative progressivity, mitigate intergenerational dependency, and maintain additional revenue streams from high-income households. Previous works by Barreix et al. (2012) and Barreix et al. (2022) outlined a PVAT as a VAT design that adheres to three principles: i) universal application, implying a general tax base; ii) a single rate, achieved by eliminating exemptions or varying rates for different goods; and iii) a self-financing tax refund to benefit the poorest population deciles, compensating for their tax burden. The authors suggested using existing social transfer program beneficiaries to implement such a design. While this approach could improve progressivity and aid revenue collection, it may not adequately address the issue of intergenerational dependency. Building on the foundational work of Barreix et al. (2012) and Barreix et al. (2022), we fortify the overall concept by allowing for specific VAT rates in accordance with an intergenerational progressive policy rule. Our research indicates that the most effective distributional tool incorporates a capital transfer to low-income households, assisting them in building savings and capital stocks. Our findings reveal that such transfers could play a crucial role in breaking intergenerational dependency.

From a theoretical standpoint, our proposed PVAT aims to impose a per-individual VAT rate. To achieve this, the theoretical PVAT requires identification of households by income groups and assignment of a specific VAT rate to each. However, in the real-world context, it would be more feasible to identify a limited number of income groups, such as recipients of government cash transfers and those who are not. The personalization of the rate can take different forms. For instance, lower-income households could be assigned a negative VAT, which could manifest as a transfer to a savings account or an instant rebate received upon purchase, potentially through a debit card currently used for government transfers. In summary, absent of an ideal world, we require adopting current technologies to identify the recipients of a PVAT.

We employ the case study of Mexico to illustrate the potential benefits of a PVAT-K qualitatively. Mexico implemented a VAT system in 1980, but the current regime includes a zero-rate VAT for food and medicines and a general rate of 16% for all other goods and services. Therefore, Mexico provides an excellent backdrop to highlight the benefits of our proposed PVAT-K. To estimate the potential benefits in a partial equilibrium setting, we first quantify the lost revenues due to Mexico's zero-rated VAT rules. Subsequently, based on national accounting statistics, we calculate revenue collection and burden for various straightforward PVAT designs. Additionally, we employ a standard econometric methodology to examine the tax incidence on households and approximate the equivalent income as a measure of welfare gains.

Our calculations, excluding general equilibrium impacts, suggest that by maintaining a zero-rated VAT on food and medicines instead of implementing a uniform 16% rate, Mexico forfeits revenues between 0.83% and 2.17% of GDP. Regrettably, standardizing the VAT rate would disproportionately impact low-income households: the first, second, and third income deciles spend, on average, 72%, 51%, and 44% of their income on food, respectively. In contrast, PVAT scenarios can be designed to generate sufficient revenues from higher-income households to offset the burden on lower-income households via a negative PVAT, an automatic transfer mechanism. Consequently, by design, it enhances both the relative and absolute progressivity of the VAT system. In fact, even the simplest PVAT design, applying a 0% VAT to households in the lowest income deciles, results in a net increase in tax collection of 0.83% of GDP. In a more refined version where each income decile has a specific progressive rate, tax collection increases by nearly 0.70% of GDP. Only when a negative PVAT is applied to the lowest income deciles to level up to the poverty line do we observe a net negative revenue collection equivalent to -0.07% of GDP. Nonetheless, this does not imply that a negative PVAT could not be budget-neutral. The aggregate unconditional transfers, including Benito Juarez Scholarships, Elisa Acuna Scholarships, and Youth Building the Future, total 1.08% of GDP (2021 budget) but do not necessarily cover the poverty line. These could be substituted by a negative PVAT, freeing up approximately 1.00% of GDP in public resources.

Partial equilibrium analysis utilizing the Mexican Household Income and Expenditure Survey (ENIGH) and national accounting data is sufficient to quantify and estimate the incidence of transitioning from VAT to PVAT. Moreover, when we compute the corresponding price elasticities by income decile, our findings suggest that a PVAT transfer that only includes households eligible for transfer programs still yields revenues of 0.56% of GDP.

Indeed, to fully explore the potential of our proposed PVAT-K, we must consider the dynamic effects that would invariably influence savings among different household cohorts. Therefore, to evaluate the economic and welfare implications of a PVAT-K, we propose a basic general equilibrium model. We utilize a two-good overlapping generation model (OLG) featuring three cohorts and two types of households: low-income and high-income. In this model, low-income households struggle to save adequately and rely on government transfers to maintain their standard of living from generation to generation, a situation not mirrored by their high-income counterparts. Our base scenario simulates a generalized VAT rate applied to both household types. We also consider three scenarios, implementing firstly a simple PVAT and then a PVAT-K. In all PVAT variations, the high-income household is taxed at a positive rate, while the low-income household is not taxed. The simple PVAT scenario naturally benefits low-income households due to a 0% VAT and lump-sum transfers. Yet, changes in demand from low-income households influence relative prices, contributing to the lifetime income of high-income households. Conversely, PVAT-K allows low-income households to accumulate capital over time, enhancing their lifetime consumption and welfare at the expense of high-income households. A PVAT-K reform, by encouraging greater capital accumulation, impacts the relative prices of goods and capital returns, both critical for wealthier households' income. For instance, a PVAT-K reform comprising only capital transfers could increase capital accumulation for low-income households by 50% above their initial steady-state baseline, resulting in wages that are 4% higher than the baseline. Similarly, this policy would lead to a new capital equilibrium for high-income households that is 45% higher than their baseline, with corresponding wages 10% above the baseline. This scenario allows low-income households to realize an average welfare gain of 1.00% more than the baseline, while high-income households endure an average loss of -0.65% compared to the baseline. The choice between a strict PVAT (lump-sum) or PVAT-K is not straightforward. Our findings imply that low-income households would experience the most significant welfare increase if the distribution places more emphasis on capital than on lump-sum transfers. This conclusion is policy-relevant, as policymakers must decide whether to adopt a PVAT reform that prioritizes current consumption (entirely lump-sum transfer) or mid to long-term consumption (entirely capital transfer or somewhere in between).

The organization of this paper is as follows. The subsequent section provides a brief literature review. We then present a case study for a PVAT, utilizing data from Mexico. Following this, we discuss VAT reform alternatives, including the abolition of the 0% VAT regime for food and medicines, along with potential PVAT scenarios. We compare the fiscal costs of implementing each scenario against the unconditional transfers currently part of Mexico's social policies. Lastly, we introduce a basic overlapping generation model to examine the general equilibrium and generational characteristics of our proposed PVAT-K. Finally, we discuss the results and draw conclusions.

2 Literature Review

Indirect taxes apply to certain economic activities. Among them, Value Added Tax (VAT) stands out as the most common consumption tax worldwide, and it is applied in most OECD countries. VAT is levied on the final price of the taxed good, so that each element of the value chain is taxed based on the added value–in its own stage of the production process–to the good. This tax thus decreases evasion through a reduction in the incentive of each value chain element to evade such tax.

The VAT, when speaking of a production process, is considered by fiscal economists an *easy* revenue creator. Keen & Lockwood (2010) describe VAT as a "money machine" in the sense that it has helped countries generate more revenues than they would have had in the absence of the VAT. In a developing economy context, Keen (2008) states that VAT taxes indirectly the informal sector because the VAT is levied on some goods used as informal sector inputs. In contrast, according to Emran & Stiglitz (2005), VAT can represent a problem when the economy has a relevant informal sector, especially when tax rates are not homogeneously applied.

For final consumption, for instance households, VAT is just a sales tax. As such, it carries the usual distortions from an intergenerational perspective. In addition, VAT hikes increase inter-temporal allocation of savings and consumption. Over the years, VAT has earned a reputation as a regressive tax, and this perception seems nowhere close to fading away. The persistence of this belief, at least among policymakers, has led to attempts to make the VAT a more progressive tax (e.g., Świstak et al. (2015), Matheson & Swistak (2014)). For this purpose, policymakers have used non-homogeneous rates, zero rates, and exemptions. The policy argument seems to be straightforward: with lower VAT rates on basic products such as food, poorer households may consume more, and their total VAT payments represent a smaller share of their income. Yet richer households also benefit from reduced rates. From a welfare perspective, lower VAT payments by poorer households are good, while lower VAT payments by richer households represent foregone revenues (Tait (1988); Matheson & Swistak (2014)).

The focal point of the discussion of the vertical equity of VAT is the question of who bears the burden or how that burden is distributed among all households. This in turn would depend on the government's preferences regarding efficiency, neutrality, and equality. Lahey (2018) noted, "IMF longitudinal data makes it clear that between 1990 and 2017, predominantly progressive tax systems in countries at all levels of development were replaced with regressive tax systems–almost always because replacing personal and corporate income tax revenues with VAT." In this regard, according to Reinsberg et al. (2020) the IMF interventions increased the likelihood of VAT introduction with reinforcing such trend. Yet, in IMF publications including Ebrill et al. (2001) Benedek et al. (2015) or Bachas et al. (2020), their recommendations are to only design VAT with a re-distributive component. Thus, recognizing that by itself the VAT is not the best redistributive tool, whereas personal income taxes are superior because they can account for individual income levels as a measure of "ability to pay." Overall, according to the IMF, VAT can still be useful for governments' social policy objectives, but largely as a means to finance the budget rather than as a direct instrument to pursue equity objectives.

In this paper, we try to contribute with novelty to the literature covering the design of a progressive VAT. Our approach is to pay attention to the share of income that households pay as VAT to design a progressive tax schedule. To attain such goals we would require, theoretically, a per-individual tax rate. In the spirit of Barreix et al. (2012) and Barreix et al. (2022), we design a Personalized Value Added Tax (PVAT). In essence, promoters of PVAT believe that as different households (different income groups) are differently exposed to purchases of necessities, different VAT rates should apply to them in order to free up enough disposable income for them to use in other productive activities.[1] Theoretically speaking a PVAT would or could reshape this marginal exposure in a progressive way. Policymakers may find attractive a PVAT that progressively applies to different income groups allowing even a negative rate for the poorest. This suggests that other unconditional transfers may be discarded and simply ensure that the PVAT is meeting a target. In our perspective, the PVAT is a step in the right direction but does not entirely contribute to solving intergenerational dependency. Thus, our proposed PVAT-K outperforms other specifications in several ways: i) it is always progressive, in terms of how much income is devoted to the tax on basic goods; ii) it can be designed to be budget-neutral; and iii) it contributes to capital savings of low-income households as households are exposed to a net rate that accounts for cash and capital transfers.

Of course, to implement a PVAT-K policymakers will face various issues. In fact, the main constraint

[1] Including education, savings, or other.

is that it would require keeping track of personal or household income, which is difficult everywhere but especially in developing countries. Nonetheless, while the ideal *theoretical* case might not be so easy to attain, there are some alternatives available to proxy the personalized VAT groups. For instance, the existence of some conditional or unconditional social benefits could help to "identify" at least a few groups. More recently, there has been a boom in poverty maps using satellite pictures that could permit the identification of households belonging to different income groups (e.g., Hersh et al. (2021), Engstrom et al. (2022)).[2]

In this paper we go beyond Barreix et al. (2012), Barreix et al. (2022), and to the best of our knowledge the current related literature by formalizing the economics behind a PVAT through an overlapping generation model (OLG). To do so we propose a basic three-cohort OLG model characterizing two agents, low-income and high-income. In our baseline, low-income adults subsidize the younger generation, leaving some resources for their own old age. Under the PVAT-K, taxes on the rich finance a cash and capital transfer for the low-income young and adult generations.

Moving from VAT to PVAT

The primary aim of a Personalized VAT (PVAT) is to develop a progressive taxation mechanism for final consumption, capable of balancing the benefits and drawbacks of deviating from conventional VAT structures (such as 0% VAT on food, differentiated rates, etc). Any reform intended to alter an entrenched VAT regime will necessitate compelling arguments to persuade policymakers. Key questions include the following: i) Can we devise a VAT schedule, with non-zero rates, that is more progressive than existing VAT designs? ii) Can this design maintain fiscal neutrality? iii) How feasible is the implementation of a PVAT in a given country? Theoretically, a PVAT aims to establish a tax rate schedule tailored to an individual's income. In essence, if we understand a person's earnings, we can assign a corresponding VAT rate progressively. Furthermore, the tax schedule can be crafted to ensure, at minimum, budget neutrality.

To illustrate how this could be feasible, we examine the VAT system in Mexico as a case study. Like many countries, Mexico has a special VAT regime for food and medicines. From the inception of the VAT system, Mexico has applied a 0% rate to these two categories of goods. While this benefits lower-income households, wealthier households also exploit these exemptions. Advocates of tax progressivity might consider this undesirable, arguing that the rich should pay full tax on all goods and services. A PVAT offers a potential solution to this issue

VAT Revenue Collection in Mexico

Mexico's VAT collection is among the lowest when compared to both OECD countries and nations across Latin America. In 2019, Mexico held the lowest position in the OECD for VAT collection. As displayed in Figure 1, Hungary, Denmark, and Finland collected over 9.5% of GDP from VAT, while Mexico collected a mere 3.8% of GDP. Although Mexico's collection is approximately half of the OECD average (7.2% of GDP), it is not substantially less than Australia (4.3% of GDP) or Japan (4.4% of GDP). Yet, when compared to

[2] The PVAT-K can also be considered as a complementary component of the retirement saving system. In contrast to the saving patterns that emerge in pay-as-you-go systems (Burbidge (1983), Kotlikoff et al. (1998)), the PVAT-K is a transfer intended to augment capital during individuals' working years. This enables households to increase their income and wealth during adulthood, providing them with greater flexibility to allocate resources towards retirement savings. In fact, if the PVAT-K is regarded as a supplementary mechanism to the pension system, it might be possible to eliminate some redundant expense. The current pension system (defined contributions through privately managed saving accounts) includes a government transfer to ensure there is a minimum saving. According to rough estimations using the National Occupation and Employment Survey (ENOE), that redundant annual expense could be around 0.30% of GDP.

other Latin American countries, Mexico lags significantly. For instance, Chile collects 8.3% of GDP from VAT, while Argentina and Brazil's VAT revenues approximate 12% of GDP.[3]

The fiscal reform of 2013-2014 introduced electronic invoicing (known as *facturación electrónica* in Spanish) and additional digital capabilities to the Mexican Internal Revenue Service (Sistema de Administración Tributaria, or SAT). Electronic invoicing complicates evasion or misreporting of expenses. Despite facilitating accounting, shell companies have manipulated electronic invoicing to sell invoices, typically for services, that carry a large VAT amount. The firms that purchase these invoices can deduct a significant amount of VAT, yet they never actually "pay" the invoiced sum, posing a considerable challenge for tax administration. Table 1 illustrates the increase in VAT collection following the full adoption of electronic invoicing. While electronic invoices are not the sole reason for improved tax collection, it is noteworthy to highlight the role they play in formalizing numerous commercial transactions and aiding tax administration.

The introduction of electronic invoicing has enhanced the VAT collection capabilities of the SAT, though evasion continues through various means. For example, shell companies have exploited e-invoicing for money laundering purposes, "selling" e-invoices for transactions that never took place. The purchasing companies can claim large VAT deductions, yet they never actually remit the invoiced amount. This practice poses a significant challenge to tax administration, particularly as it undermines the corporate income tax base. Furthermore, e-invoicing has not effectively addressed the prevalent practice of cash-based commercial transactions, which frequently evade the SAT's oversight. In summary, while the adoption of e-invoicing has improved certain aspects of tax administration, it has not entirely resolved all issues related to tax compliance.

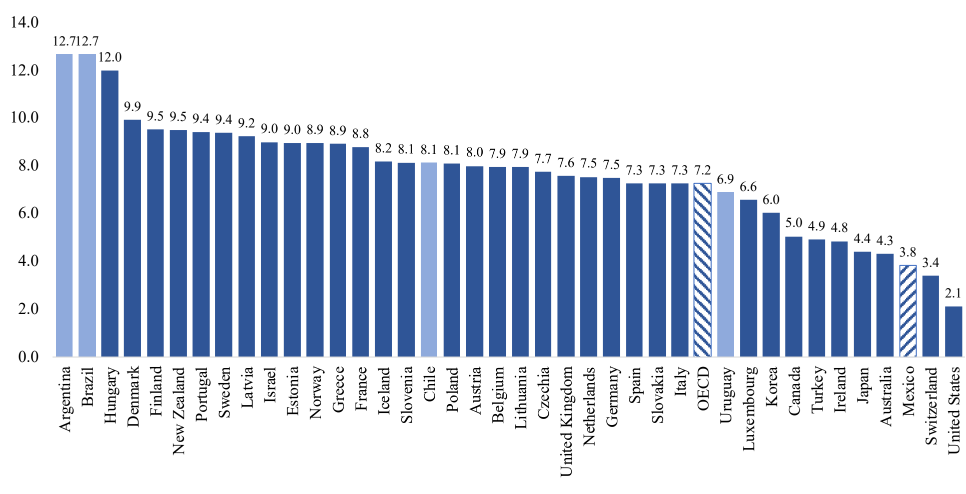


Figure 1: Indirect Tax Revenues (% of GDP)
Source: OECD.

One prominent example of VAT collection loss in Mexico is the tax administration of professional services. Given the prevalent use of cash, professional services are often rendered without issuing an invoice. Without an e-invoice, the SAT cannot trace the tax base for the VAT, leading to missed tax collection opportunities from these service providers. A range of professional services falls into this "informal" category, including medical doctors, accountants, notaries, legal services, civil engineers, and architects, among others. According to Ayllon-Aragon et al. (2018), tax evasion by doctors reached 29.62% in 2016, a figure equal to a third

[3]VAT collection as percentage of GDP is extracted from OECD Tax Database (OECD (2023)) and includes overall consumption tax collection: national and subnational.

Table 1: Tax Revenues and E-Invoicing

Year	No. e-invoices		Income Tax		VAT		Income Tax		VAT	
			Personal	Corporate	Personal	Corporate	Personal	Corporate	Personal	Corporate
	Million	Growth (%)	Million Current Pesos				Million Real Pesos			
2011	2,915.71		418,659.70	303,175.80	9,871.00	527,120.20	418,659.70	303,175.80	9,871.00	527,120.20
2012	5,897.40	102.26	471,745.90	288,360.30	11,599.70	568,395.70	453,116.00	276,972.55	11,141.61	545,948.96
2013	9,662.43	63.84	514,640.30	392,199.00	12,894.00	543,908.00	476,190.76	362,897.23	11,930.67	503,271.83
2014	14,799.97	53.17	514,277.00	469,023.70	16,526.90	650,558.20	457,470.61	417,215.93	14,701.36	578,698.36
2015	20,582.09	39.07	609,617.20	625,066.00	19,136.80	688,076.50	527,916.93	541,295.29	16,572.11	595,861.19
2016	26,724.58	29.84	682,782.30	740,122.60	20,051.00	771,647.80	575,050.28	623,343.20	16,887.28	649,894.24
2017	33,242.10	24.39	755,087.00	810,127.00	20,352.70	795,686.40	599,714.95	643,429.53	16,164.78	631,960.33
2018	40,170.11	20.84	805,133.00	855,478.60	21,207.20	901,029.90	609,596.84	647,715.41	16,056.78	682,204.03
2019	47,888.65	19.21	830,229.97	853,193.82	24,547.52	908,779.24	606,544.97	623,321.78	17,933.80	663,931.08

Source: SAT and Mexican Ministry of Finance.

of the value added that they contribute to the economy! The study identified three common methods used by professional service providers to evade VAT: i) cash payments, ii) refusal to issue invoices regardless of payment method, and iii) over-declaration of VAT deductions.

However, the primary source of inefficiency in VAT collection lies elsewhere. The failure to apply the tax universally to all goods and services reportedly results in the largest revenue loss for the public sector.[4] In 2013, the federal authority initiated steps to generalize VAT. The VAT Federal Law (Ley del Impuesto al Valor Agregado (LIVA)) was amended to implement a uniform 16% rate nationwide, eliminating any differential tax treatment among regions and states.[5] Despite this, the law preserved the zero-rate VAT for food and medicine. The elimination of the zero-rate VAT remains a hotly debated topic among Mexican legislators. The different proposals to address the zero-rate VAT range from outright elimination to gradual phasing out. However, arguments against these changes, particularly the potential adverse impact on the poor, carry significant weight among legislators. Our proposed PVAT could offer a viable alternative to address these concerns: it provides a design where the poor can find relief from the tax burden even after the complete elimination of the 0% rates. Therefore, policymakers may find compelling arguments for PVAT, considering both the social impact and the potential for increased revenue collection.

Foregone Revenues of 0% VAT. A crucial aspect of the existing VAT regime in Mexico is the revenue foregone due to the 0% VAT on food and medicines. We first attempt to quantify the potential revenues that the Federal Government misses out on as a result. We extend the methodology suggested in Barreix et al. (2022), which primarily relies on household expenditure surveys to account for household spending on zero-rated goods.[6] To evaluate how these foregone revenues have evolved over time in Mexico, we employ the National Household Income-Spending Survey (ENIGH) 2014, 2016, and 2018.[7] We also utilize the Economic Census to glean additional information.[8] Using the ENIGH, we aim to approximate the value arising exclusively from household's final consumption. We subsequently explore the broader economy using the Input-Output (I-O) matrix.

[4] As will become apparent later in this section, without considering general equilibrium elements, the lost revenue could range between 0.83% and 2.17% of GDP.

[5] However, in 2019, the government decreed a new Special Economic Zone (SEZ). Unlike its predecessor, the SEZ would reduce VAT from 16% to 8% provided i) companies are registered and operate in counties bordering the United States, ii) their profits are primarily generated within the border area, and iii) the lower rate applies only for intermediate consumption.

[6] Barreix et al. (2022) utilize only household expenditure surveys to obtain final consumption expenditure for Argentina, Dominican Republic, Costa Rica, and Uruguay to simulate a PVAT reform.

[7] ENIGH is available biennially. We did not use the 2020 version as it was an atypical year due to the COVID-19 pandemic.

[8] The base year is 2014, published in 2015.

Estimating Foregone Revenues from Households

The LIVA stipulates a 16% VAT for all consumer goods, barring a subset of products. Those subject to a 0% VAT are listed in LIVA Art. 2. Additionally, there is a subset of activities under a VAT exemption regime, as outlined in LIVA Art. 9. Generally, only primary food products and certain processed foods carry a 0% VAT. The logic behind this is straightforward: processed foods are not in their natural state, as they have been cooked or mixed with other ingredients. The value-added contributions of processed products at each stage of production accumulate. This accumulation of value-added, in theory, forms the basis for the application of a value-added tax. However, primary or raw foods, typically considered in their natural state, have little to no added value.[9,10]

Table 2: Goods Subject to 0% VAT: NAICS and ENIGH Codes

NAICS Code	Sector	ENIGH Codes	Note
11	Agriculture	A001, A018, A019, A101-A104, A107-132, A137-A141, A144, A147-A170, A178, A183-A185, A203, A204	
311	Processed Foods	A002-A017, A020-A100, A105, A106, A133-A136, A145, A146, A195-A197, A210-A212	
312112	Bottled water, ice, water services	A215, A222 and R002	
3254	Drugs and Medicines private sector	J001, J004, J005, J020-J035, J042, J044-J059.	Variable org_inst from the survey filters from government and private sector.
	Drugs and Medicines public sector	J001, J004, J005, J020-J035, J042, J044-J059.	Variable org_inst from the survey filters from government and private sector.

Source: Own elaboration using ENIGH (2018).

The LIVA incorporates medicines within its special zero-rate regime. The reasoning behind this is that out-of-pocket expenses can be high, disproportionately impacting low-income households. However, in practice, a range of private sector actors also benefit from this zero taxation, calling into question the fairness of the regulation. Furthermore, according to the most recent health reforms in 2020 and 2022, public hospitals will cover the cost of most medications for the general population. This should theoretically reduce out-of-pocket expenses, making the 0% VAT rate on medicines unnecessary. Thus, only those not willing to use the public health system will incur an out-of-pocket expense including the VAT. Moreover, abolishing the 0% rate for pharmaceuticals would increase costs for the public sector, as it would have to bear the tax burden when purchasing medicines from pharmaceutical companies. However, the net effect turns out to be positive, as government spending on medicines is less than 10% of private spending.

Tax Expenditure due to 0% VAT on Food and Medicines. Our first step is to properly quantify the tax expenditure due to the 0% VAT.[11] To do so, we compute the value of final household consumption,

[9] There are other specific taxes and fees in the tax code, such as excise taxes or differently evaluated taxes. Here, we focus on the general rate and the zero rate regime.

[10] Court rulings have also altered how the LIVA must be applied to some subjects. For instance, in Alsea vs. SAT, the judge ruled in favor of Alsea, enabling them to apply the zero rate in their fast-food chains like Domino's Pizza, Chili's, and Burger King.

[11] Tax expenditure corresponds to the tax the public sector is not collecting as a result of a special tax regimen. In our case

C_t, currently levied at 0% VAT. We thus assume that household do not purchase goods as intermediate consumption. According to ENIGH, some of the 0% VAT goods may be found within the classification of primary sector, processed foods, bottled water, ice and water services, and drugs/medicines. Table 2 shows the exact codes that we used within each classification.

Table 3 shows the resulting values for tax expenditures for the years that the survey is available. According to these figures, by lifting the 0% VAT and generalizing it to 16%, fiscal revenues would increase by 1.03% of GDP.

Table 3: VAT Revenues using ENIGH (Million Mexican Pesos and % of GDP)

Zero Rated Goods			
		Tax Expenditure	
Year	Value of Consumption	Pesos	(% GDP)
2014	1,105,852.63	176,936.42	1.01
2015	1,178,856.03	188,616.96	1.02
2016	1,298,734.34	207,797.49	1.03
2017	1,430,182.97	228,829.27	1.04
2018	1,516,088.31	242,574.13	1.03

Source: Authors' estimations based on ENIGH.

Foregone Revenues from the Entire Economy

The calculations above may appear insignificant for a country the size of Mexico. However, they do not account for households operating outside the formal economy or other potential general equilibrium effects. Table 4 presents historical fiscal revenues from income and value-added taxes. It is worth noting that in 2019, VAT revenues from individuals amounted to about 0.1% of GDP. Therefore, assuming all other things being equal (*ceteris paribus*), eliminating the 0% VAT could potentially boost revenue collection by approximately 1.0% of GDP, effectively doubling the current value.[12]

As shown in Table 4, the corporate sector is currently the primary source of VAT collection. To estimate how a VAT reform could yield increased revenues, we must expand our perspective beyond households and account for the potential revenues lost in the wider economy. This requires considering all intermediate consumption purchased by the private productive sector, along with domestic final consumption by households, firms, government, and foreign entities.[13] Our approach combines data from the I-O Matrix, national accounts, and official public finance data from the Ministry of Finance (see Table 5). While national accounting data are readily available for all years, intermediate consumption data can only be extracted from the I-O matrix. Unfortunately, INEGI publishes the I-O matrix only every four years, and the most recent version was published in 2014. We consequently had to create an updated version.

Table 6 summarizes the results for potential revenues resulting from winding down the 0% VAT. The I-O matrix suggests that the potential revenues after removing the 0% VAT and placing a 16% rate raises in 2.17% of GDP. This 2.17% comprises the economy as a whole, subtracting the VAT collection from households (Table 3) approximates the contribution of the corporate sector to around 1.14% of GDP.

Two details are to be taken into account. First, these calculations are a broad estimate of the potential revenues. Because there are many particularities regarding the possible lawful deductions that are allowed

study, tax expenditure is the amount of the VAT that SAT is not collecting due to the 0% rate.

[12] Again, these figures do not factor in income or price substitution effects or any other general equilibrium effects. We will address tax incidence later in this document.

[13] For a detailed explanation of the methodology used to compute the economy's potential revenues, see Appendix A.

Table 4: Tax Revenues as % of GDP

Year	No. e-invoices		Income Tax		VAT	
			Personal	Corporate	Personal	Corporate
	Million	Growth (%)	Percentage of GDP			
2011	2,915.71		2.85	2.07	0.07	3.59
2012	5,897.40	102.3	2.98	1.82	0.07	3.59
2013	9,662.43	63.8	3.16	2.41	0.08	3.34
2014	14,799.97	53.2	2.94	2.68	0.09	3.72
2015	20,582.09	39.1	3.28	3.37	0.10	3.70
2016	26,724.58	29.8	3.39	3.68	0.10	3.83
2017	33,242.10	24.4	3.44	3.69	0.09	3.63
2018	40,170.11	20.8	3.42	3.64	0.09	3.83
2019	47,888.65	19.2	3.40	3.49	0.10	3.72

Source: Authors' estimations using SHCP and INEGI data.

Table 5: Data Sources

NAICS Code	Sector	Source		
		Consumption		Value Added
		Intermediate	Final	
11	Agriculture	I-O Matrix	INEGI SNA	INEGI SNA
311	Processed Foods	I-O Matrix*	INEGI SNA	INEGI SNA
312112	Bottled water, ice, water services	I-O Matrix*	INEGI SNA	INEGI SNA
3254	Drugs and Medicines private sector	I-O Matrix*	INEGI SNA	INEGI SNA
	Drugs and Medicines public sector	SHCP*	SHCP	SHCP

Source: Authors' compilation. * approximated using the data source.

under the zero-rated regime it is highly likely that revenues would be a bit lower. In fact, these theoretical figures need to be adjusted to reflect the nature of the VAT payment incidence of each economic activity. To do this, the estimate must be polished by taking into account that the observed average added value that is contained in the value of production varies between economic activities. For example, in the production of agricultural goods, this proportion is 64%, while in processed foods is 43%. Another way to see this is by analyzing the effective VAT rates paid by each economic activity.[14]

Table 6: VAT Revenues using the I-O Matrix (Million Mexican Pesos and % of GDP)

Year	Zero Rated Goods		
	Value of Consumption	Tax Expenditure	
		Pesos	(% GDP)
2014	2,250,428.80	360,068.61	2.06
2015	2,431,234.07	388,997.45	2.09
2016	2,629,096.56	420,655.45	2.09
2017	2,968,963.51	475,034.16	2.17
2018	3,194,947.04	511,191.53	2.17

Source: Authors' calculations using National Accounts from INEGI.

Alternative Designs for a PVAT

A PVAT aims to enhance the progressivity of the VAT. As we have previously discussed, it is critical from a public finance perspective to maintain a tax schedule that is at least as effective as the current VAT system. Policymakers may be more inclined to support the progressivity of the PVAT compared to a 0%

[14]Using SAT and INEGI data, the average VAT rate is 10.5% across all economic activities. This means that the likely value of additional collection from the corporate sector is closer to 0.72% of GDP than 1.14%.

VAT on food and medicines. However, they may be less supportive if the PVAT collects fewer revenues than the VAT. Any VAT reform will necessitate compelling arguments to persuade lawmakers and policymakers to endorse it. The intriguing question is, can we design a VAT schedule with non-zero rates that is more progressive? We hypothesize that a PVAT could be a feasible solution. We aim to demonstrate that, provided we know individual incomes, we can assign a specific VAT rate in a progressive manner that maintains budget neutrality.[15]

Returning to the Mexican case, who benefits from the 0% VAT in Mexico? Tables 7 to 9 provide initial insights into a potential PVAT reform.[16] Table 7 indicates that lower-income deciles spend a larger portion of their income on food and medicine than wealthier households. Higher-income households, on average, are least "exposed" to the tax burden, yet they bear the largest expenses on food and medicines. For instance, about 72% of decile I's expenditure goes to food, while decile X, on average, spends about 2.5 times what decile I does. However, for households in this group, it only represents 9.56% of their income. Without an effective mechanism to rebate or transfer the VAT back to low-income households, increasing the rate would more severely impact their income compared to wealthier households. Therefore, implementing such a policy could be politically unfeasible.

In an ideal world, a PVAT would set a specific rate for each household based on their income group.[17] Now, Tables 8 through 9 present what we believe to be feasible VAT/PVAT schedules.

The first scenario (columns (4), (5), and (6)) illustrates a standard VAT reform: a universal 16% rate. As anticipated, this standardization would generate revenues surpassing 1.03% of the GDP. However, it imposes the highest fiscal burden (as a percentage of income) on the lowest decile. Therefore, Scenario 1 showcases a VAT reform that, while maximizing revenue compared to other scenarios, is strictly regressive. The next set of columns ((7) to (9)) display the simplest version of a PVAT reform. If one's income falls below a specific threshold (decile III), the rate is effectively 0%; otherwise, it is 16%. This basic design separates the population into two distinct groups based on the country-specific definitions: the poor and the non-poor.[18] Column (9) demonstrates that this two-tier PVAT schedule maintains a 0% tax burden for the low-income group. However, a closer look at the middle deciles reveals that our PVAT does not address the large incidence they bear compared to the higher-income deciles. One final observation is that while this PVAT rule is not perfectly progressive, it manages to collect an additional 0.83% of the GDP. This amount is roughly a quarter of what the SAT could collect if the 16% rate were applied universally.

Alternative configurations might result in a more progressive design for the PVAT. We present two more examples in Table 9. Initially, columns (4) to (6) in Table 9 display a monotonic VAT structure within the $(0, 16]$ range. Column (6) reveals that income distribution in Mexico is heavily skewed towards deciles IX and X. Despite this PVAT schedule, we do not achieve full progressivity. A higher VAT rate for deciles IX and X would be necessary to attain this. This PVAT schedule also generates additional revenue, approximately 13,000 million pesos, equivalent to 0.66% of the GDP.

If we are limited to a maximum VAT rate of 16%, another option is considering a negative tax for certain

[15]While the primary objective of an ideal PVAT is to achieve progressivity and fiscal neutrality, it can also be designed to incentivize or discourage the consumption of specific goods. However, this approach comes with two drawbacks: i) it would require the elimination of redundancies with other excise taxes, which could present political complexities; and ii) it could pose administrative burdens.

[16]The calculations related to PVAT in what follows consider the information from ENIGH. Therefore, it does not include the collection of VAT that comes from government expenditure or private sector companies.

[17]Our main focus here is discussing the transition from a zero-rated VAT on food and medicines to a PVAT system. While we will only consider these goods, the same methodology can be extended for a broader approach, encompassing all goods and services subject to the LIVA.

[18]The income threshold is twice the average poverty line defined by The National Council for Evaluation of Social Program (CONEVAL) in 2018 - 2x $3,336.14 monthly pesos - equating to $6632.27 pesos.

income brackets. Given that the government collects additional revenues when all but the lower deciles pay 16%, it is feasible to design a budget-neutral PVAT that includes a negative tax. Alternatively, this could mean providing a direct transfer to households' bank accounts, equivalent to a certain percentage of their expenditure. For administrative purposes, such a measure would need to be capped at a certain monthly amount. Consider a PVAT rule that a country like Mexico could easily implement: the government wants to guarantee a transfer equal to the poverty line, regardless of the average household income, let us say, monthly $3,316.14. In this case, we would need to design a negative VAT schedule. Columns (7) to (9) in Table 9 depict such a rule, where households within deciles I and III receive a monthly transfer of 3,316 pesos.[19]

Regrettably, this specific PVAT schedule is not budget-neutral.[20] In fact, as displayed at the bottom of Table 9, this PVAT schedule would result in a net revenue loss of around 15,500 million pesos. In a country like Mexico, there are several ways to ensure that such a rule is at least budget-neutral, either by adjusting the VAT rate for deciles IV-X, or by eliminating all other social cash transfers to these households. The cost of the main five government transfer programs–*Jóvenes Construyendo el Futuro*, *Jóvenes Escribiendo el Futuro*, *Pensiones para el Bienestar*, *Programa de Becas Benito Juárez*, and *Programa de Becas Eliza Acuña*–account for approximately 2% of the 2021 GDP (SHCP (2021)). It is worth noting that maintaining the 0% rate results in revenue losses nearing 2.2% of GDP.

Table 7: Household Monthly Expenditure (Monthly Pesos, unless otherwise specified)

		Avg. Household	Average Expenditure			
Income	Num.	Monthly Current	Food		Medicines	
Decile (1)	Households (2)	Income (3)	Current Pesos (4)	% of Income (5)	Current Pesos (6)	% of Income (7)
I	3,136,141	2,904.26	2,083.62	71.74	37.96	1.31
II	3,178,084	5,096.62	2,559.39	50.22	44.60	0.88
III	3,267,581	6,774.67	2,916.53	43.05	37.17	0.55
IV	3,338,683	8,438.07	3,176.10	37.64	53.31	0.63
V	3,450,475	10,205.25	3,448.20	33.79	46.67	0.46
VI	3,493,385	12,320.40	3,611.94	29.32	50.01	0.41
VII	3,533,453	14,908.92	3,850.11	25.82	63.91	0.43
VIII	3,601,781	18,528.34	4,038.21	21.79	63.55	0.34
IX	3,702,155	24,543.58	4,384.79	17.87	84.60	0.34
X	4,043,080	52,044.57	4,977.89	9.56	210.32	0.40

Source: Authors' compilation using data from ENIGH (2018).

[19]To implement this policy, the beneficiaries would need to be i) part of a cash transfer program (paid via debit card) and when not, then ii) maintain a formal reporting of income to the SAT and usage of debit card.

[20]This design not only maintains budget neutrality, but also elevates the first three income deciles significantly beyond the fourth. A more refined design would only transfer the required amount to meet an income goal. Though, countries might find this more challenging to implement.

Table 8: Hypothetical Examples of a VAT Reform (Monthly Pesos, unless otherwise specified)

Income Decile (1)	Number of Households (2)	Avg. Household Monthly Current Income (3)	Scenario 1 Flat 16% Rate: Rate (%) (4)	Monthly Revenue Collected (5)	Share of Income (%) (6)	Scenario 2 16% in Highest 7 Deciles: Rate (%) (7)	Monthly Revenue Collected (8)	Share of Income (%) (9)
I	3,136,141	2,904.26	16.00	339.45	11.69	0.00	0.00	0.00
II	3,178,084	5,096.62	16.00	416.64	8.17	0.00	0.00	0.00
III	3,267,581	6,774.67	16.00	472.59	6.98	0.00	0.00	0.00
IV	3,338,683	8,438.07	16.00	516.71	6.12	16.00	516.71	6.12
V	3,450,475	10,205.25	16.00	559.18	5.48	16.00	559.18	5.48
VI	3,493,385	12,320.40	16.00	585.91	4.76	16.00	585.91	4.76
VII	3,533,453	14,908.92	16.00	626.24	4.20	16.00	626.24	4.20
VIII	3,601,781	18,528.34	16.00	656.28	3.54	16.00	656.28	3.54
IX	3,702,155	24,543.58	16.00	715.10	2.91	16.00	715.10	2.91
X	4,043,080	52,044.57	16.00	830.11	1.60	16.00	830.11	1.60
Total Monthly Revenues (Million Pesos)				20,214.51			16,281.59	
Total Annual Revenues (% GDP)				1.03			0.83	

Source: Authors' compilation using data from ENIGH (2018).

Table 9: Hypothetical Examples of VAT Reform (b) (Monthly Pesos, unless otherwise specified)

Income Decile (1)	Number of Households (2)	Avg. Household Monthly Current Income (3)	Scenario 3 Sequence 1.6% - 16%: Rate (%) (4)	Monthly Revenue Collected (5)	Share of Income (%) (6)	Scenario 4 Transfer to First Three Deciles: Rate (%) (7)	Monthly Revenue Collected (8)	Share of Income (%) (9)
I	3,136,141	2,904.26	1.60	33.95	1.17	83.41	-3316.13	114.18
II	3,178,084	5,096.62	3.20	83.33	1.63	33.24	-3316.13	65.07
III	3,267,581	6,774.67	4.80	141.78	2.09	21.34	-3316.13	48.95
IV	3,338,683	8,438.07	6.40	206.68	2.45	16.00	516.71	6.12
V	3,450,475	10,205.25	8.00	279.59	2.74	16.00	559.18	5.48
VI	3,493,385	12,320.40	9.60	351.55	2.85	16.00	585.91	4.76
VII	3,533,453	14,908.92	11.20	438.37	2.94	16.00	626.24	4.20
VIII	3,601,781	18,528.34	12.80	525.03	2.83	16.00	656.28	3.54
IX	3,702,155	24,543.58	14.40	643.59	2.62	16.00	715.10	2.91
X	4,043,080	52,044.57	16.00	830.11	1.60	16.00	830.11	1.60
Total Monthly Revenues (Million Pesos)				12,896.29			-15,492.96	
Total Annual Revenues (% GDP)				0.66			-0.07	
Total Annual Revenues (% GDP)				0.66			-0.07	

Source: Authors' compilation using data from ENIGH (2018).

Incidence Analysis

While we made use of National Accounting in the previous section to approximate the potential effects in households and the economy of a PVAT reform, such analysis abstracts from household behavioral effects when prices change via tax rates. Therefore, the adequate procedure is to estimate household elasticities per decile that allow us to capture such behavior. We perform an incidence analysis of changes of the VAT rate on different households (within different income percentiles) through econometric procedures, again the ENIGH (2018). The ENIGH Survey design is representative at national-level aggregation and the sample size is large enough for statistical inference at the state level. ENIGH includes information from the spending and the income side as well as other household characteristics and variables to measure living conditions. The sample represents about 34 million households. Regarding the goods we are analyzing in this paper (food, water, and drugs/medicines), the questionnaire allows us to distinguish up to 6 digits of the NAICS classification. Finally, we used the INEGI prices data to construct when needed the Paasche price indexes for each of the food, water, and drugs/medicine groups.

Our econometric strategy to assess the incidence of transiting to a general 16% rate or to any of the PVAT scenarios is based on the quadratic version of an Almost Ideal Demand System (QUAIDS). First, AIDS has been developed by Deaton & Muellbauer (1980) and has become one of the most popular demand systems in the economic literature. To the best of our knowledge, in Mexico, previous work to measure tax reform incidence with micro data is Urzúa (2001), who makes use of an AIDS. It constitutes a practical way of modeling expenditures with several commodities and satisfies basic economic assumptions on consumer behavior while being simple and straightforward to estimate. Thus, we follow to some extent Deaton & Muellbauer (1980). Accordingly, the utility maximization by the representative consumer yields the following *share equations* in logs:

$$w_i = \alpha_i + \sum_k \phi_{i,k} log(P_{i,k}) + \beta_i log(I) + \lambda_i (log(I))^2, \tag{1}$$

where the share of demand for good i is denoted w_i and it is a function of the price of all other goods ($P_{i,k}$), and also function of total household income (I).

An important estimation issue raised in Urzúa (2001) is related to endogeneity. As he does, we are also aware that the proxy for the income effect, I, is an endogenous variable (because I is endogenous), and this might seriously affect the quality of the parameter estimates. In terms of the estimation procedures, we use as a proxy for income the reported household expenditure in real terms E/P. Therefore, our QUAIDS specification is the following:

$$w_i = \alpha_i + \sum_k \phi_{i,k} log(P_{i,k}) + \beta_i log(E/P) + \lambda_i [log(E/P)]^2, \tag{2}$$

where E is divided by an overall price index, P.[21]

We impose a set of restrictions to the previous equation, relating to consistency with consumer theory. First, coefficients for cross-price effects should be symmetric across equations (symmetric Slutzky matrix); second, (4) guarantees that all shares add to 1, third, condition (5) implies that total expenditure should vary in the same proportion as a uniform change in all prices (homogeneity in prices). Finally, condition (6)

[21] The Tornqvist (or Paashe) price index P typically involves all prices, and it can be computed as a weighted price index using as weights the shares in total demand of the goods. In our case, our QUAIDS model is estimated in two steps. First, we estimate the system assuming $P = 1$. Then, we use the coefficients obtained from the first step to compute P and estimate the system a second time.

also implies the quadratic expenditure should vary uniformly in the quadratic prices:

$$\phi_{i,k} = \phi_{k,i}, \quad (3)$$

$$\sum_i \alpha_i = 1, \quad (4)$$

$$\sum_k \phi_{i,k} = 0, \forall i. \quad (5)$$

$$\sum_i \lambda_i = 0, \forall i. \quad (6)$$

Given the above conditions, we can estimate each of the demand parameters. Once the econometric estimation is done, we will be able to use the demand parameter estimates to compute own-price and cross-price elasticities between product groups.[22] The Marshallian own-price elasticity, measuring the change in the quantity demanded for good i resulting from a change in its own price, is thus computed as follows:

$$\epsilon_{i,i} = -1 + \frac{\phi_{i,i}}{w_i} - \beta_i. \quad (7)$$

In contrast, the Marshallian cross-price elasticity, measuring the change in the quantity demanded for good i resulting from a change in the price of a different good, k:

$$\epsilon_{i,k} = \frac{\phi_{i,k}}{w_i} - \beta_i(\frac{w_k}{w_i}). \quad (8)$$

Finally, the expenditure elasticity, i.e., the percent change in total demand for good i when total expenditure on all goods changes:

$$\Theta_i = 1 + (\frac{\beta_i}{w_i}). \quad (9)$$

The own-price and cross-price elasticities are the central objects of our empirical analysis. With the former, we can predict the change in the quantity demanded for any given commodity following a VAT change, for instance from zero-rated to a generalized regime. With the latter, it is possible to assess the degree of substitution patterns among consumption goods and services as their prices change following the indirect tax adjustment.

To ensure the most refined estimations of incidence, we use when appropriate a Quadratic Almost Ideal Demand System (QUAIDS) in the spirit of the micro-simulation model developed by Abramovsky et al. (2011).[23] Their methodology is useful for our analysis of VAT as it can quantify the revenue and distributional impact of tax reforms under both the assumption that individuals do not change their behavior as a consequence of changes in taxes, and the assumption that individuals react to these changes along specific margins.[24] The QUAIDS is a generalization of the AIDS. This is a useful demand system that allows the share of each type of good in total expenditure to vary in a flexible way with goods able to be luxuries (i.e., having an income elasticity of greater than 1) at one level of total expenditure and necessities (i.e., having an income elasticity of less than 1) at another (Banks et al. (1997)). The model assumes that the utility

[22]As in Urzúa (2001) we follow the definitions in (Green & Alston (1990)).

[23]We estimate a QUAIDS or AIDS depending on statistical significance.

[24]Full details of the simulator program can be found in background papers including Abramovsky et al. (2010), Abramovsky et al. (2011), and Abramovsky & Phillips (2015).

obtained from any particular good is not affected by the amount one works (and therefore demand for goods is also unaffected), and it does not allow for positive or negative externalities from expenditure on certain goods (for instance fuel, alcohol and tobacco).[25] Estimating the QUAIDS would necessary lead to a rapid increase of the number of parameters to be estimated, especially if we increase the number of product groups and subgroups. Therefore, we aggregate the household expenditure categories first into those that, according the VAT Law (*Ley del Impuesto al Valor Agregado*) and the Tax Code (*Codigo Fiscal de la Federacion*), have a 0% rate: i) Primary Food and Processed Foods, ii) Medicines; iii) Alcoholic Beverages and Tobacco, iv) Water-Related Goods and Services, and in group v) all other goods.

Before moving forward with all estimations, it is worthwhile to comment some details about the data. As discussed in Urzúa (2001), we also face the fact that some households have zero monetary expenditures for some food products, albeit reporting non-monetary expenditures for them. We decided to use the total expenditure on such goods since it is very likely that household use a monetary transaction for the acquisition of such goods. This implies that households under-report their monetary spending. Some possible explanations are discussed in Urzúa (2001) and they are valid as well for our study. Moreover, we also checked the size of transfers and public benefits (government cash transfers and other monetary programs) to validate some probable behavior of households reporting in ENIGH. Transfers and benefits account for a larger share of total reported income in lower income groups. On average, transfers seem to account for the average expenditures within zero-rate foods and medicines.

Going back to our task of estimating equation (2), we perform the well-known Zellner SURE (Seemingly Unrelated Regression Equations) method, imposing linear homogeneity and symmetry conditions on parameters. With these estimations we can compute the impact of the proposed VAT change. Our simple methodology for the incidence analysis of these increases is summarized as follows: i) the impact of rising prices is first mapped onto households' real consumption expenditure through the demand elasticities estimated above, then ii) we analyze the distributional impact of varying consumption expenditure levels by computing simple expenditure bundles *ex-ante ex-post* a PVAT reform. Also, the new levels of consumption are compared against the national poverty line to compute the incidence of poverty.[26] Finally, we estimate the impact of price changes on consumer welfare using the computed demand functions. An attractive measure of the welfare impact is the equivalent income (EI): the change in income a household would require in order to make them indifferent between the original price vector (with the original income) and the new price vector.

Table 10 summarizes the equivalent income of each of the income deciles for four main zero-rate VAT transition scenarios: i) a 16% flat rate for every income decile; ii) a 0% rate in the first three income deciles, and then a 16% flat rate in the remaining 7 deciles; iii) a sequence from 1.6% in decile I all the way to 16% for decile X; and iv) a negative rate equal to a transfer of $3,314 pesos (monthly) for the first three deciles with a 16% rate for the remaining seven income deciles.

The table presents two columns per scenario. The first corresponds to the EI and the second to the percentage change relative to the current status of the tax rate. For instance, in Scenario 1, the EI that households within the 3 first deciles require to equivalently be as before, ranges between 93 and 220 pesos monthly, or equivalently about 3.2% less than before the rate increase–unlike what we showed using national accounting, where their burden increases from 0 to an average of 409 pesos for the first three deciles. Once the price elasticities are taken into account, the equivalent income required to keep them indifferent is only

[25]All the estimations results are available in Appendix C

[26]The national poverty lines coincide with those from the National Evaluation Council (CONEVAL) for 2018.

about 28% to 54% of such figures. That result comes from the highly elastic behavior of this consumption group in these deciles. For example, the own price elasticity of zero-rated goods in the first three income deciles averages about -1.5.[27] This implies a 16% increase in price would reduce the quantity demanded of such consumption group to almost 24%. Furthermore, the cross-price elasticity of changes in the first group of goods (zero-rated food) for the first three deciles is mostly positive for all other groupings, implying the increase in price yields a substitution effect with other groupings. Therefore, the 16% VAT rate price increase would decrease consumption for the next three deciles. Now, would a decrease in income ranging between $233.9 and $253.51 result in a transition to a lower decile? No, a generalized VAT rate of 16% in food and medicines would still keep people in their current income groups.

In our Scenario 2, by construction, we do not observe any negative effect on deciles I-III. Yet, the remaining deciles will face a flat rate of 16%. Differently from the calculations based on SNA (see Table 8), our incidence estimation suggests substantially lower equivalent income adjustments, ranging between 271 and 78 pesos monthly. Once again the price elasticities inform us that these households are able to decrease their demand for zero-rated food and substitute for other processed foods that are currently subject to a VAT, thus reducing their exposure to the the tax increase on food and medicines.

For Scenario 3, the equivalent income averages approximately 103 monthly pesos and still leaves people in their corresponding income decile. Finally, Scenario 4, which includes the government transfer, increases the disposable income for every household in the three lowest income deciles. Once accounting for elasticity effects, the EI equivalent to a transfer of $3,316.14 monthly pesos (as in Table 9) is lower. In particular, the equivalent income changes for deciles I, II, and III are $1599.78, $497.80, and $379.52 monthly pesos, respectively. Furthermore, the monthly transfer of $3,316.14 pesos would allow households in decile I to progress to an income level of decile II. Households in decile II would be able to transition to decile III, and households in decile III would be able to achieve income levels corresponding to decile IV.

Table 10: Incidence of a PVAT Reform (Monthly Mexican Pesos, unless otherwise specified)

Income	Num.	Scenario 1 Flat 16% Rate		Scenario 2 16% in the highest 7 Deciles		Scenario 3 Sequence 1.6% - 16%		Scenario 4 First Three Deciles Transfer	
Decile	Households	Equiv. Income ($)	% Change	Equiv. Income ($)	% Change	Equiv. Income ($)	% Change	Equiv. Income ($)	% Change
I	3,471,276	-93.54	-3.22	-	-	-10.26	-0.35	1,599.78	55.08
II	3,468,669	-166.13	-3.26	-	-	-35.98	-0.71	497.80	9.77
III	3,471,882	-219.86	-3.25	-	-	-70.70	-1.04	379.52	5.60
IV	3,471,295	-233.92	-2.77	-233.92	-2.77	-99.38	-1.18	-233.92	-2.77
V	3,472,469	-228.33	-2.24	-228.33	-2.24	-119.52	-1.17	-228.33	-2.24
VI	3,471,806	-253.51	-2.06	-253.51	-2.06	-157.84	-1.28	-253.51	-2.06
VII	3,472,304	-270.96	-1.82	-270.96	-1.82	-194.83	-1.31	-270.96	-1.82
VIII	3,473,877	-155.97	-0.84	-155.97	-0.84	-127.20	-0.69	-155.97	-0.84
IX	3,470,654	-151.69	-0.62	-151.69	-0.62	-137.85	-0.56	-151.69	-0.62
X	3,471,988	-78.34	-0.15	-78.34	-0.15	-78.34	-0.15	-78.34	-0.15

Source: Authors' compilation using data from ENIGH (2018).

Beyond the particular design of the best PVAT, policymakers are concerned with its implementation. The challenge in a context of high informality, inaccurate compliance incentives, and weak enforcement of tax administration, is to actually perfectly identify who falls into each PVAT bracket. So, why do we think that a PVAT is implementable? There are several reasons that, at least in the case of Mexico, we believe can make it work. First, the SAT has greatly improved its digital capabilities and can even process immediate tax returns when purchases are made electronically. On the other hand, the recent administration opted to create pay-all transfers via the national public bank. That is, all Government programs are paid through *Banco del Bienestar* via debit cards.[28] The remaining effort is to link each of these debit cards to a tax

[27] See Appendix C for the estimated elasticities by income decile.

[28] Banco del Bienestar, previously known as BANSEFI, is a public bank whose main objective is to promote development in marginalized communities.

identification number or *Registro Federal de Contribuyentes* (RFC). The SAT is able to inform in almost real time to each banking institution whether the debit card user is or not part of a benefits program. Thus, an "almost immediate" VAT personalized rate, and any tax return or transfer can be applied directly to the bank account.[29]COMA[30]

Moreover, it would be relatively easy to implement a slight refinement of our simplest PVAT scenario (Scenario 4). Instead of discriminating by decile, SAT could include those who meet the criteria to be part of a social transfer. Even this simple version would benefit public finances. As noted aboves, the universe of beneficiaries of the five main programs costs approximately 2% of GDP. Table 11 shows such refinement to our Scenario 4 by selecting only the households that qualify for such programs. Using the ENIGH, about two-thirds of the total number of households in the first three deciles qualify to receive a PVAT transfer. Using the equivalent income (EI) calculated from the QUAIDS estimation, the government revenues from a PVAT as in Scenario 4 would increase revenues from 0% to 0.56% of the GDP. In other words, that design costs 0.27% of GDP (via a PVAT transfer to poor households) but collects 0.83% of GDP on all other households, thus having a net positive effect on revenues of 0.56% of GDP. Finally, it is worth noticing that under this PVAT, gains are potentially larger: the government could stop spending 2% of GDP by substituting current social transfer programs and paying instead the PVAT transfer, overall increasing disposable government income by about 2.56% of GDP.

Table 11: Scenario 4: Incidence of a PVAT Reform in Qualifying Households (Mexican Pesos, and % of GDP)

Income	Num.	Qualifying	EI	Annual Government Revenues	
Decile	Households	Households	(Monthly Pesos)	Million Pesos	% GDP
I	3,136,141	2,142,925	1,599.78	-41,138.63	-0.17
II	3,178,084	2,088,955	497.80	-12,478.60	-0.05
III	3,267,581	2,112,164	379.52	-9,619.18	-0.04
IV	3,338,683	-	-233.9	20,701.4	0.09
V	3,450,475	-	-228.3	23,153.2	0.10
VI	3,493,385	-	-253.5	24,561.7	0.10
VII	3,533,453	-	-271.0	26,553.6	0.11
VIII	3,601,781	-	-156.0	28,365.4	0.12
IX	3,702,155	-	-151.7	31,769.1	0.14
X	4,043,080	-	-78.3	40,274.6	0.17
Total	9,581,806	6,344,044	2,477.10	132,142.70	0.56

Source: Authors' compilation using data from ENIGH (2018).

Another possibility that can be explored in Mexico involves the set of workers (public and private sector) who receive a regular salary. Federal law mandates all corporations and institutions paying regular salaries to enroll their employees under a specific fiscal regime, the "salary regime."[31] All workers under this fiscal regime must receive their payment through a debit card. This fiscal regime also involves an e-invoice reporting the breakdown of all payroll items. As the same law specifies, the e-invoice must be generated by the employer through any of SAT's e-invoicing providers and deliver a copy to the employee. Because the SAT owns all the information contained in every e-invoice, income information for this universe of people, can also be used for any PVAT design (i.e., apply a more progressive rate: the higher the salary, the higher the PVAT rate). As

[29]While all the conditions are met for that implementation, the success of that implementation depends on how the SAT matures technologically and administratively, and according to that progress a PVAT design could work either for specific groups or could be massively implemented.

[30]The use of targeted technological means for delivery or reimbursement, as envisioned by PVATK, has also been discussed in the context of Digital VAT Ainsworth (2005), which takes into account additional criteria like the consumer's health condition, education, and even geographical location.

[31]The Income Tax Law or LISR, describes the salary regime, under the chapter of personal income tax.

a final remark, it is in the interest of the Government to promote banking or financial technologies, so some of the benefits of the PVAT could be linked to the use of digital means to carry out commercial transactions.

To conclude, in this section we shed some light on the possible effects of a PVAT reform once taking into account household behavior. In the above sections we have described different tax schedules that could contribute to the progressivity of the VAT. Nonetheless, there are some other dynamic considerations of taxes that could influence their effects on income, consumption, or saving decisions overtime. One must go beyond partial equilibrium and make the analysis more robust in at least two ways: i) including mechanisms that allow the PVAT to be a factor of intergenerational mobility; and ii) expanding the analysis using a general equilibrium perspective. In the next section, we characterize a PVAT reform with an intergenerational general equilibrium model framework. Moreover, we introduce a capital transfer instead of (or together with) a lump-sum transfer to represent in a simple way any type of capital saving that contributes to the enhancement of long-run labor's marginal productivity (i.e., structurally increase labor income) and/or capital income.

A PVAT with Capital Transfers from the Intergenerational Perspective

There has been widespread use of dynamic overlapping generations (OLG) life-cycle models to analyze the economic effects of tax reforms. For the purpose of this paper it is the ideal economic model, and its usefulness is manifest in two main characteristics. First, the agents are heterogeneous in terms of their ages, which seems to be an important difference in terms of economic decision making.[32] In addition, an OLG framework assumes that the lifetime of an individual is finite and must eventually end. In the absence of bequests, there are not complete markets between unborn and living cohorts. Another key feature that makes an OLG model ideal for our research is that they allow answering questions about policies that affect age cohorts differently, for instance, taxes or saving policies. In addition to the static analysis (based on current wealth or annual income), there are several reasons for taking a lifetime approach together with differentiated age cohorts. It allows extracting information relevant to issues of inequality and fiscal progressivity including, (a) heterogeneity of the patterns of income, taxes and transfers payments throughout the life cycle; (b) second, annual variations in income, particularly due to the realization of capital gains, suggest that labor income should not be the only indicator of spending capacity in the longer term; and (c) finally, persons in different stages of the life cycle, have income, taxes, and transfer payments that are closely related to their longer-run spending capacity.

In their computable versions, generations are characterized by a large number of adult cohorts and sometimes also have multiple types of individuals with varying life time incomes within each cohort. These models are especially well-suited to analyzing both the short-run transitional and the long-run dynamic macroeconomic effects of tax reforms, especially the time paths of reform-induced changes in labor supply, saving and investment, as well as the redistributional effects of reforms, including changes in the prices of existing assets, across and within generations. The use of OLG models in the analysis of tax reforms are based on the seminal contribution of Auerbach & Kotlikoff (1987).[33]

[32] For instance, the saving decisions of a 20-year-old are different compared to those a 60-year-old.

[33] To further exemplify the usefulness of these OLG computable models, more recently, in Benzell et al. (2019),Benzell et al. (2017), Benzell et al. (2021), Benzell, Kotlikoff, and Lagarda worked a series of global large-scale OLG models to simulate different U.S. Corporate Tax Reforms, including the reaction of other countries in a race to the bottom, the role of hydrocarbon output, and the increase of automation.

Inspired by the Auerbach-Kotlikoff framework, we present a baseline OLG model to characterize the main features of a PVAT. The model is a perfect foresight, 3-period-lived agent OLG model. Three generations–representing age groups–are alive during each period in the model.[34] We assume that a unit measure of individuals are born each period, and each generation of individuals lives for three periods in order to characterize three critical moments: children & young, middle-age adults, and old & retired. Individuals inelastically supply labor every period, choose how much to consume, and how much to save through capital. A unit measure of identical, perfectly competitive firms rent investment capital from households and hire labor from households. As in some applications of the Auerbach and Kotlikoff framework, we are able to perform the calculation of an optimal path for investment in response to changes in the tax structure, which in turn implies the model can be used to track the economy in each period following reform until it reaches a new steady state (rather than simply comparing the steady states before and after reform). This allows a thorough analysis of the transitional effects of reform.

To thoroughly investigate the potential of our proposed PVAT, we have crafted its structure in harmony with a specific distributional policy that includes capital transfers, namely PVAT-K. This strategy is aimed at enabling low-income households to accumulate capital, thereby augmenting both their labor and capital income. The decision to deploy a PVAT-K, however, is not clear-cut. Policymakers are faced with the critical decision of either prioritizing immediate consumption (through an entirely lump-sum transfer) or focusing on mid to long-term consumption (through an entirely capital transfer, or a combination of both).

The Model

We propose a perfect foresight OLG model with two types of households, the high-income and low-income. They both pay a final consumption tax, earn labor and capital income but only the low-income benefit from government transfers. Both households obtain utility from consumption. Furthermore, our utility functions abstain from the effects of leisure in labor supply. Although assuming an inelastic supply is restrictive, we believe that our model allows us to focus attention on savings patterns as we restrict social transfers to the low-income households.[35] There are also two kinds of goods produced with constant returns on scale technologies. Each is produced in a different sector that uses specific capital and labor, and differ only by a total factor productivity parameter. Finally, the assumption of perfect foresight implies that firms and households systematically and rationally form expectations about the future, including all of the future effects of PVAT changes.

We chose to characterize these features through a three-cohort setup for several reasons. It is typical that low-income households in all countries, but especially in developing economies, divide their income between family members. Middle-age adults reserve a share of their income to finance and pay for at least the minimum needs of their children. Of course, if household income or wealth is large enough this is not a problem at all. However, when this is not the case, then middle-adults must altruistically reserve a larger share of their income for their children. This creates an intergenerational poverty trap through lower savings and access to capital that leads to lower welfare throughout generations.

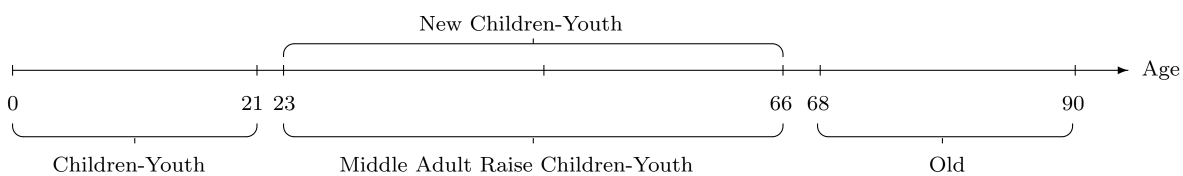
[34] A 3-period-lived agent OLG model actually has the same properties as an S-period lived agent model. We thus use a 3-period-lived agent model in this section, but the same analytics and computational solution extends to an $S - period$ lived agent OLG model.

[35] In Mexico, the evolution and expansion of the transfer program *Oportunidades* have been studied by academia from various perspectives. For instance, according to Bosch et al. (2012) the effect of *Oportunidades* in the labor market within 2000-2010 was not associated with drops in either labor force participation or wage formality. In fact, the expansion was strongly correlated with the transition of the unemployed to self-employment, suggesting the program did not generate any dependence from social transfers.

Thus, in our setting, children and youngsters entering working age need to allocate income for consumption and, whenever possible, savings. But the only source of income comes from a stipend directly transferred by the middle-age adult (parents). We also assume that, regardless of being high or low-skill, the older generation does not receive any labor income or accumulate additional savings. They only consume using the resources that they were able to save during their middle-age adulthood. Therefore, the burden of early and late consumption falls on middle-age adults: they need to allocate resources for their own consumption and for their children, and save for their retirement. Figure 2 graphically simplifies what we try to represent with three stages during each life cycle. Approximately, the children-youth would range from 0-early 20s, the middle-age adult between mid-20s and mid-60s. Last, the old would be living between their retirement age (late 60s) and their death, say, by 90 years old. Finally, employment in our model is not mobile between sectors, which is consistent with the persistence of informality in Mexico. In contrast, both types of households are able to access the same returns on their capital savings.

Through the next subsections we first present an analytical result and then, due to the complexity of the expressions, we simulate the solution of our proposed model using Mexico as case study.

Figure 2: The Individual Life-Cycle and Hypothetical Aging



Households

Whether households have high or low income, they maximize utility of consumption:

$$U(c_{1,z}, c_{2,z}, c_{3,z}) = u(c^x_{1,t,z}, c^y_{1,t,z}; \phi_z) + \beta u(c^x_{2,t+1,z}, c^y_{2,t+1,z}; \phi_z) + \beta^2 u(c^x_{3,t+2,z}, c^y_{3,t+2,z}; \phi_z), \tag{10}$$

where ϕ^s represents a vector of parameters informing about weight that the agent assigns to each good and β is the discount parameter. As for notation simplicity, in $c_{s,t+1,z}$, the age of an individual is indexed by $s = \{1, 2, 3\}$ standing for young, middle-age adult, and old, respectively; $z = \{h, l\}$ correspond to high and low-skill household, respectively; and $t + j$ for $j = \{0, 1, 2\}$ is the time period of the living cohort.

Both households, which are earning labor and capital income, have different propensities to consume; thus, a change in labor's share of income $(1 - \alpha_z)$ can have important effects on saving and investment due to the logarithmic utility function, which allows fixed shares of consumption and saving, and our production function framework, which is embodied in a standard Cobb-Douglas function.

Higher-Income Households

A unit measure of identical high-income individuals are born each period and live for three periods. Children receive a family stipend $e_{t,h}$. They distribute their income flow to consume $c^x_{1,t}$ and $c^y_{1,t}$ at price p_t. Any difference between their consumption and their income stipend is saved $S_{1,t+1,h}$. The VAT (τ^i_z, $i = \{x, y\}$, $z = \{h, l\}$) is collected proportionally through their consumption

$$(1+\tau_h^x)C_{1,t,h}^x + p_t(1+\tau_h^y)C_{1,t,h}^y + S_{1,t+1,h} = e_{t,h}. \tag{11}$$

For simplicity we will denote with $\hat{C}_{1,t,z}^i$ the consumption including tax, that is $(1+\tau_z^i)C_{1,t,z}^i = \hat{C}_{1,t,z}^i$. We can rewrite equation (11) as

$$\hat{C}_{1,t,h}^x + p_t\hat{C}_{1,t,h}^y + S_{1,t+1,h} = e_{t,h}. \tag{12}$$

Middle-age adults receive labor income $w_{t+1,h}$ and collect any capital income ($r_{t+1,h}$) from their savings. However, their disposable income results from subtracting the stipend they assign to their children. With the available income, then, they consume, pay taxes, and save.

$$\hat{C}_{2,t+1,h}^x + p_{t+1}\hat{C}_{2,t+1,h}^y + S_{2,t+2,h} = w_{t+1}^h + (1+r_{t+1}^h)S_{1,t+1,h} - e_{t+1,h}. \tag{13}$$

Finally, when old, high-skills households will no longer earn labor income, and their only source of income will come from returns on their savings.

$$\hat{C}_{3,t+2,h}^x + p_{t+2}\hat{C}_{3,t+2,h}^y = (1+r_{t+2}^h)S_{2,t+2,h}. \tag{14}$$

The high-skill households save in the form of capital, $k_{s,t+1,h}$, when they are young and middle-age adults, but they no longer save when old:

$$S_{1,t+1,h} = k_{1,t+1,h}, \tag{15}$$

$$S_{2,t+2,h} = k_{2,t+2,h} - \delta_h k_{1,t+1,h}, \tag{16}$$

$$S_{3,t+3,h} = 0. \tag{17}$$

Furthermore, parents give an endowment to their children based on their period's income,

$$e_{t+j,h} = \bar{e} + \psi_h(w_{t+j}^h + r_{t+j}^h S_{1,t+j,h}), \tag{18}$$

where $\bar{e}$ represents a rigid spending, like food and medicines for the young, ψ_h is the share of their expenditure on the parent's income, and $j = \{0,1,2\}$.

By combining the above equations we can express a lifetime budget constraint:

$$\hat{C}_{1,t,h}^x + \hat{C}_{1,t,h}^y + \frac{\hat{C}_{2,t+1,h}^x + \hat{C}_{2,t+1,h}^y}{1+r_{t+1}^h} + \frac{\hat{C}_{3,t+2,h}^x + \hat{C}_{3,t+2,h}^y}{(1+r_{t+1}^h)(1+r_{t+2}^h)} = W(w_{t+1}^h, r_{t+1}^h, \bar{e}). \tag{19}$$

Finally, the right-hand side comprises lifetime accrued income,

$$W(w_{t+1}^h, r_{t+1}^h, e_{t,h}) = e_{t,h} - \frac{e_{t+1,h}}{1+r_{t+1}^h} + \frac{w_{t+1}^h}{1+r_{t+1}^h}. \tag{20}$$

Lower-Income Households

Low-income households, like high-income households, also endow their children based on their current income,

$$e_{t+j,l} = \bar{e} + \psi_l(w_{t+j}^l + r_{t+j}^l S_{1,t+j,l}), \tag{21}$$

where $\bar{e}$ represents a rigid spending, like food and medicines for the child, ψ_l is their share in the expenditure on the parent's income, and $j = \{0, 1, 2\}$.

Unlike the high-income, low-income households are not initially endowed with large amounts of capital, nor are they able to transfer large value stipends ($e_{t,l}$) to their children. They then have to consider seeking additional transfers T_t, in the form of social programs. The budget for transfer is bounded only by VAT tax collection. The remainder is then divided among cohorts. That distribution is represented by ω_i with $i = \{1, 2, 3\}$. By doing this we try to represent the multiplicity of social transfers that exist–for children, for adults responsible for their households, and for the old.

As occurs with the high-skill household, on the other hand, the younger generation saves $S_{1,t+1,l}$ and receives some return r^l_{t+1}. Middle-age adults use labor income to consume and contribute to the younger generation's needs, saving whatever remains. This formulation attempts to characterize a situation in households with low initial capital where middle-age adults need to deploy a relatively important amount of their income to their children. By doing so, they both reduce their savings and limit their consumption opportunities. Finally, when adults are old they consume by exhausting their savings plus any additional government transfer. Thus, the low-income face the following budget constraints:

$$\hat{C}^x_{1,t,l} + p_t\hat{C}^y_{1,t,l} + S_{1,t+1,l} = e_{t,l} + \omega_1 T_t, \tag{22}$$

$$\hat{C}^x_{2,t+1,l} + p_{t+1}\hat{C}^y_{2,t+1,l} + S_{2,t+2,l} = w^l_{t+1} + (1 + r^l_{t+1})S_{1,t+1,l} - e_{t+1,l} + \omega_2 T_{t+1}, \tag{23}$$

$$\hat{C}^x_{3,t+2,l} + p_{t+2}\hat{C}^y_{3,t+2,l} = (1 + r^l_{t+2})(S_{2,t+2,l} + \omega_3 T_{t+2}). \tag{24}$$

The lifetime budget constraint reduces to

$$\hat{C}^x_{1,t,l} + \hat{C}^y_{1,t,l} + \frac{\hat{C}^x_{2,t+1,l} + \hat{C}^y_{2,t+1,l}}{1 + r^l_{t+1}} + \frac{\hat{C}^x_{3,t+2,l} + \hat{C}^y_{3,t+2,l}}{(1 + r^l_{t+1})(1 + r^l_{t+2})} = W(w^l_{t+1}, r^l_{t+1}, \bar{e}, T_t),$$

where for simplicity we group each period consumption into $C_{1,t,l}$, $C_{2,t+1,l}$, and $C_{3,t+2,l}$, respectively.

Finally, as in the case of the high-skill, the right hand side include all the lifetime sources of income

$$W(w^l_{t+1}, r^l_{t+1}, e_{t,l}, T_t) = e_{t,l} + \frac{w^l_{t+1}}{1 + r^l_{t+1}} + \omega_1 T_t - \frac{e_{t+1,l}}{1 + r^l_{t+1}} - \frac{\omega_2 T_{t+1}}{1 + r^l_{t+1}} - \frac{\omega_3 T_{t+2}}{(1 + r^l_{t+1})(1 + r^l_{t+2})}.$$

Overall, at any period of time t, the government transfers and wasteful spending must be fully financed by tax revenues, with $0 \leq \theta \leq 1$

$$\sum_{s=1}^{3} \hat{C}^x_{s,t,z} + \sum_{s=1}^{3} p_t\hat{C}^y_{s,t,z} = \theta \sum_{s=1}^{3} \omega_s T_t + (1 - \theta)G_t \tag{25}$$

The PVAT and Lower-Income Households

Under a same distributional policy, a basic PVAT would be an improvement on a traditional VAT only to the extent that the tax burden would follow a more progressive schedule. To represent that feature in our model, for each group of households, we suppose the following PVAT rates schedules,

$$\tau = \begin{cases} \tau > 0 & \text{if High-Income} \\ \tau = 0 & \text{if Low-Income} \end{cases} \tag{26}$$

Differently from a basic PVAT policy, our stronger version of a PVAT jointly considers progressivity principles and distributional features through capital savings. To connect the economic importance of a PVAT with a generational welfare transition, we need to think about the PVAT not only as a current revenue source but also as a capital saving mechanism. In fact, whenever the PVAT is negative it can be thought as a transfer. Rather than a traditional transfer, however, it represents a direct source of capital savings for the younger generation, that is, a PVAT-K policy. This has an important advantage. First, instead of having the middle-adult reduce their savings to help fulfill the younger generation's spending needs, the PVAT-K could provide a way to progressively help them to accumulate capital for their middle-adult phase. This in turn would have the goal of inducing intergenerational change such that future younger generations reduce their dependency on older generations.[36] How do we model life before the PVAT-K? In the absence of a capital-inducing PVAT, the younger generation receives a direct monetary transfer that will be available for their present time consumption but not exclusively to create savings. In other words, regardless if there is a traditional VAT or a basic PVAT in place, before a PVAT-K policy, φ_t is simply a monetary lump-sum transfer T_t,

$$\varphi_t = \begin{cases} T_t & \text{if T-VAT} \\ k_{t \to t+1} & \text{if PVAT-K} \end{cases} \tag{27}$$

Thus, the younger generation's budget constraint when the PVAT condition (27) holds can be written as

$$\hat{C}^x_{1,t,l} + p_t \hat{C}^y_{1,t,l} + S_{1,t+1,l} = e_{t,l} + \omega_1 k_{t \to t+1,l}. \tag{28}$$

In summary, under a PVAT-K policy they only receive a transfer–in the form of capital–when they are young and middle-age adults:

$$S_{1,t+1,l} = k_{1,t+1,l}, \tag{29}$$

$$S_{2,t+2,l} = k_{2,t+2,l} - \delta_l k_{1,t+1,l}, \tag{30}$$

$$S_{3,t+3,l} = 0. \tag{31}$$

Production

The PVAT is a design that tries to accomplish progressivity and revenue collection goals better than the current VAT designs. Also, because many countries currently have a VAT and zero-rated goods, as like Mexico, we propose a two-sector economy. Sector Y_t includes all the goods that are subject to a full VAT rate. Sector X_t represents the goods and services that usually are subject to a zero-rate VAT. The price index for this bundle of goods and services is p_t. Furthermore, we assume that high-income human resources are

[36] As with any OLG model that incorporates an instrument emulating future income, there is a possibility that the agent will reduce their savings. A clear example is the discussion of pay-as-you-go systems. However, in our model where three generations coexist, this may not necessarily be the case. The capital transfer–regardless of its form–increases the wealth of the working generation (adults), which is the only one capable of saving in normal conditions. The elderly generation, on the other hand, only receives the fruits of their life savings, so the disincentives that occur in the classical formulations of Samuelson (1958) or Aaron (1966) may not necessarily arise.

employed exclusively in the sector that typically has a full VAT. Conversely, lower-income human resources are hired in the economic activities subject to a zero rate VAT. For convenience, we selected the good produced by low-income households (good x) as the numeraire good ($p_t = \frac{p_{t,y}}{p_{t,x}}$).

High-Income Sector

This economy includes identical perfectly competitive firms that rent investment capital from high-income households for real return r_t^h and hire high-income labor for real wage w_t^h. Firms use their total capital k_t^h and labor H_t to produce output Y_t every period according to a Cobb-Douglas production technology. Assuming a unit of high-skill labor, these type of firms maximize their profits:

$$\begin{aligned} \underset{k_{t,h}}{\text{Max}} \quad & p_t Y_t - w_t^h - r_t^h k_{t,h} \\ \text{subject to} \quad & Y_t(k_{t,h}) = A_t k_{t,h}^{\alpha_h}, \end{aligned}$$

with first order conditions:

$$p_t(1-\alpha_h)A_t k_{t,h}^{\alpha_h} = w_t^h, \tag{32}$$

$$p_t \alpha_h A_t k_{t,h}^{\alpha_h - 1} = r_t^h. \tag{33}$$

Low-Income Sector

Similarly, assuming a unit of low-income labor, in this sector firms maximize their profits in the form:

$$\begin{aligned} \underset{k_{t,l}}{\text{Max}} \quad & X_t - w_t^l - r_t^l k_{t,l} \\ \text{subject to} \quad & X_t(k_{t,l}) = B_t k_{t,l}^{\alpha} l, \end{aligned}$$

and first order conditions:

$$(1-\alpha_l)B_t k_{t,l}^{\alpha_l} = w_t^l, \tag{34}$$

$$\alpha_l B_t k_{t,l}^{\alpha_l - 1} = r_t^l. \tag{35}$$

The key difference between these two types of firms is that if $k_{t,h} = k_{t,l}$, then $w_t^h > w_t^l$ entirely due to $A_t > B_t$.[37]

Finally, no-arbitrage requires

$$r_t^l = \alpha_l B_t k_{t,l}^{\alpha_l - 1} = p_t \alpha_h A_t k_{t,h}^{\alpha_h - 1} = r_t^h, \tag{36}$$

which implies,

$$p_t = \frac{\alpha_l B_t k_{t,l}^{\alpha_l - 1}}{\alpha_h A_t k_{t,h}^{\alpha_h - 1}}. \tag{37}$$

[37] Assuming the Inada condition to avoid optimal corner decisions, note that for the old and retired, $k_{3,t,z} > 0$ always in equilibrium. This is because if, $k_{3,t,z} \leq 0$ in any period, then $c_{2,t,z} \leq 0$. Now, if $k_{2,t,z} > 0$ always, then $k_{1,t,z} > 0$ also because $c_{1,t,z} < 0$ when $k_{1,t,z} < 0$. Furthermore, labor and capital income are both > 0, and consumption is a fixed share of both in logarithmic utility functions.

Equilibrium Conditions and Market Clearing

Consider $s = \{h, l\}$. Then, whether they are high (h) or low (l) income households, demands for consumption and investment satisfy

$$(1+\tau_{x,s})c^x_{1,t,s} = (\frac{\phi^s}{1+\beta(1+\beta)})W^s_t, \tag{38}$$

$$(1+\tau_{y,s})p_t c^y_{1,t,s} = (\frac{1-\phi^s}{1+\beta(1+\beta)})W^s_t, \tag{39}$$

$$(1+\tau_{x,s})c^x_{2,t+1,s} = (\frac{\beta\phi^s}{1+\beta(1+\beta)})W^s_t, \tag{40}$$

$$(1+\tau_{y,s})p_{t+1} c^y_{2,t+1,s} = (\frac{\beta(1-\phi^s)}{1+\beta(1+\beta)})W^s_t, \tag{41}$$

$$(1+\tau_{x,s})c^x_{3,t+2,s} = (\frac{\beta^2}{1+\beta(1+\beta)})\phi^s(1+r_{t+2,s})S_{2,t+2,s}, \tag{42}$$

and

$$(1+\tau_{y,s})p_{t+2} c^y_{3,t+2,s} = (\frac{\beta^2}{1+\beta(1+\beta)})(1-\phi^s)(1+r_{t+2,s})S_{2,t+2,s}, \tag{43}$$

Equilibrium requires market clearance in all markets: For all $z \in \{x, y\}$, let

$$C^z_{1,t} = \sum_{s\in l,h} C^z_{1,t,s}, \tag{44}$$

$$C^z_{2,t} = \sum_{s\in l,h} C^z_{2,t,s}, \tag{45}$$

$$C^z_{3,t} = \sum_{s\in l,h} C^z_{3,t,s}. \tag{46}$$

Then the supply-demand clearance condition for sector X_t at any t takes the form

$$X_t = C^x_{1,t} + C^x_{2,t} + C^x_{3,t} + I_{t,l}, \tag{47}$$

where

$$I_{t,l} = S_{1,t+1,l} + S_{2,t+1,l} = k_{t+1,l} - \delta_l k_{t,l}, \tag{48}$$

$$I_{t+1,l} = S_{1,t+2,l} + S_{2,t+2,l} = k_{t+2,l} - \delta_l k_{t+1,l}, \tag{49}$$

$$I_{t+2,l} = S_{1,t+3,l} + S_{2,t+3,l} = 0, \tag{50}$$

and for the Y_t sector at every t

$$p_t Y_t = p_t C^y_{1,t} + p_t C^y_{2,t} + p_t C^y_{3,t} + I_{t,h}, \tag{51}$$

where

$$I_{t,h} = S_{1,t+1,h} + S_{2,t+1,h} = k_{t+1,h} - \delta_h k_{t,h}, \tag{52}$$

$$I_{t+1,h} = S_{1,t+2,h} + S_{2,t+2,h} = k_{t+2,h} - \delta_h k_{t+1,h}, \tag{53}$$

$$I_{t+2,h} = S_{1,t+3,h} + S_{2,t+3,h} = 0. \tag{54}$$

Now, the government budget constraint requires in the baseline scenario, for all t:

$$\sum_{i=1}^{3} \tau_z^y p_t C_{i,t,z}^y + \sum_{\tau=1}^{3} \tau_z^x C_{i,t,z}^x = \theta \sum_{\tau=1}^{3} \omega_i T_t + (1-\theta) G_t \tag{55}$$

that is, θ percent of the government revenues equal the transfer given to the low-income households and the remainder is wasteful spending to good Y.

When implementing the PVAT, the government budget constraint takes the form

$$\sum_{i=1}^{3} \tau_h^y p_t C_{i,t,h}^y + \sum_{\tau=1}^{3} \tau_h^x C_{i,t,h}^x = \theta \varphi_t + (1-\theta) G_t, \tag{56}$$

Therefore, the PVAT transfer on the low-income household is financed entirely by the VAT rate high-income households pay on both goods.

Steady State and Numerical Solution

The proposed model keeps track of two saving behaviors, one for the high-income agent and another one for the low-income agent. Having three-period adds enough complexity to prevent from finding a closed-form analytical solution. In order to show the key features, we begin by considering the case of a high-income household. In this case, the high-income saving behavior turns out to be a variation of the basic 2-period OLG saving equation, depicted by

$$k_{t+1,h} = (p_t(1-\alpha_h)A_t k_{t,h}^{\alpha_h} - e_{t,h} + p_{t+1}\alpha_h A_{t+1} k_{t+1,h}^{\alpha_h})\left(\frac{\beta}{1+\beta(1+\beta)}\right), \tag{57}$$

while a capital-adjusted saving equation for the low-income

$$k_{t+1,l} = ((1-\alpha_l)B_t k_{t,l}^{\alpha_l} - e_{t,l} + \alpha B_{t+1} k_{t+1,l}^{\alpha_l} - \omega_2 \varphi_{t,l})\left(\frac{\beta}{1+\beta(1+\beta)}\right), \tag{58}$$

and finally, a price equation, result of the no-arbitrage condition

$$p_t = \frac{\alpha_l B_t k_{t,l}^{\alpha_l - 1}}{\alpha_h A_t k_{t,h}^{\alpha_h - 1}}. \tag{59}$$

To obtain an analytical steady state, notice that previous system requires two additional equations to find a solution. In order to achieve identification, we included the savings equations of the young cohort for each type of household. In particular,

$$k_{t+1,h} = e_{t,h} - \frac{1}{1+\beta(1+\beta)}\left(\frac{p_{t+1}(1-\alpha)A_{t+1}k_{t+1,h}^{\alpha} - e_{h,t+1}}{1+\alpha A_{t+1}k_{t+1,h}^{\alpha-1}}\right), \tag{60}$$

and

$$k_{t+1,l} = e_{l,t} - \frac{1}{1+\beta(1+\beta)}\left(\frac{(1-\alpha)B_{t+1}k_{t+1,l}^{\alpha} - e_{l,t+1} - \omega_2\varphi_{t+1,l}}{1+\alpha B_{t+1}k_{t+1,l}^{\alpha-1}}\right) - \omega_1 \varphi_{t,l}. \tag{61}$$

Finally, while we only require savings and price paths to compute the model variables, we found that including the consumption equations explicitly helped in reducing the relative error of the government revenues condition. In that sense, all of our simulations include consumption paths.

The Solution Algorithm

Given the non-linearity of the system, we decided to rely on numerical procedures to obtain the equilibrium paths of the Baseline (full VAT rate on both households) and the PVAT Scenario (PVAT rate on low-income households). We included the savings equations of both households, the returns and wages from firms, the relative price, and a balanced budget condition, thus, becoming a non-linear constrained optimization. We used two types of algorithms. The first is a trust-region method that relies on a quasi-Newton procedure to obtain the local minima of the linearized system given an initial guess and a designated region to find it. It works as follows: compute the second order Taylor approximation of the nonlinear system, then evaluate the gradient and the Hessian matrix of the system on an initial guess x_0 plus a step size δ, if $(x_1 = x_0 + \delta_0)$ is close to finding the local minima, then change δ_0 to δ_1, such that $x_2 = x_1 + \delta_1$ and $\delta_0 > \delta_1$ if not, increase δ_0 to δ_1' such that $x_2 = x_1 + \delta_1'$ and $\delta_0 < \delta_1'$. We repeated this until convergence.

The second is an algorithm based on the work of Levenberg (1944) and Marquardt (1963) (L-M), which combines the Gauss-Newton method and the Gradient Descent to find the local minima of the residuals of the linearized system by adjusting a dampening parameter λ to the regular Gauss-Newton update. When λ decreases, the algorithm approximates the Gauss-Newton method. On the other hand, when λ increases, the algorithm approximates a Gradient Descent. The algorithm works as follows, compute the Jacobian matrix (J) of the residuals of the system (r). Then, evaluate the numerical derivatives of the system $J(X_i + \Delta X_i))$ with $(X_{i+1} = X_i + \Delta X_i)$ where X_i is an initial guess by computing its second order Taylor expansion. The Taylor expansion implies $J(X_{i+1}) \approx J_F(X_i)\Delta X_i = -F(X_i)$. In an nonlinear squares problem $J_F(X_i)\Delta X_i = -F(X_i) \rightarrow J_F(X_i)^T J_F(X_i)\Delta X_i = J_F(X_i)^T r(X_i)$, commonly known as the Gauss-Newton Algorithm for nonlinear least squares. Yet, the L-M algorithm includes the dampening parameter λ, resulting in $(J_F(X_i)^T J_F + \lambda I)(X_i)\Delta X_i = J_F(X_i)^T r(X_i)$. If $\lambda = 0$, then the algorithm resembles the Gauss-Newton algorithm, if $\lambda \rightarrow \infty$, then the algorithm resembles the Gradient Descent method to find the steepest direction. The values of λ and X_i increase or decrease until convergence.

Finally, the solution algorithm uses as main criteria of convergence the norm of the overall set of variables. We pay particular attention to overall convergence while keeping prices and market-clearing conditions within a tolerance of 0.001. On average, our relative error of the price and market-clearing conditions across simulations is of 0.71%.

Parameter Selection

Tables 12 and 13 summarize the selection of parameters we used to evaluate the effects of a PVAT reform in both types of households. For the high-income households, we assume that the production function is more capital intensive, this is reflected by a parameter α_h of 0.50. On the other hand, low-income households have a more labor-intensive production function, with a parameter α_l of 0.10. We assume parameter β is a standard discount rate for both models with a value of 0.94. Another difference in parametrization lies on the total factor productivity of each sector. In the case of formal good y, has a higher TFP than low-income good X. Therefore, we assumed A_t is equal to 1 whereas B_t is equal to 0.46. Now, parameter ϕ was calibrated using the consumption of low-income good X from the ENIGH (2018). We cataloged low-income goods by using the location reported in the survey of where the good was purchased. For example, if a household reports consuming a good that has zero-rated VAT in the local market, then the good is identified as low-income. On the other hand, if a household reports consuming a zero-rated good in an establishment, we catalog it as high-income. The calibrations yield a value of 0.19 for low-income households (first three income deciles) and a value of 0.20 for high-income households (remaining 7 income deciles).

We chose to model the effects of PVAT through the use of the tax rates τ_h^i and τ_l^i. For both households, the baseline case portrays a generalized 16% VAT rate on both goods. In contrast, the PVAT scenario includes a 16% VAT rate for high-income households and a rate of 0% for low-income households. Having two different goods is also critical for our analysis. Because we are interested in how a PVAT may improve revenue collection and progressivity, we would like to study the dynamics when all goods face the same VAT rate but also when initially some goods have a different rate, as usually happens (i.e., 0% VAT rate is usually applied to primary goods, food or prescription drugs). We will try to represent that situation by keeping track of two goods before and after a PVAT reform. Moreover, we assumed the depreciation rate is equal between households, with δ_h and δ_l equal to 1.00. This means that capital depreciates completely in each period. As mentioned before, low-income adults are required to provide an endowment for children and also save for when they are old, generating an inter-generational poverty trap. To assimilate this behavior, the endowment share of income is calibrated to match data from the ENIGH (2018), where the share of the children's consumption is over 8% ($\psi_l = 0.08$) of household current income. For high-income households, this share decreases to 5% of household current income ($\psi_h = 0.05$). This means that because high-income households obtain higher income levels, they do not need to provide their children with a higher endowment as percentage of their income, thus becoming less of a burden for the high-income adult vis-a-vis the low-income adult. Furthermore, the rigid endowment $\bar{e}$ is calibrated to match the share of consumption of food and medicines for the children in the ENIGH (2018) as a share of household current income, a value of 0.01.

Another parameter that changes between scenarios is the government transfer φ_t. In our Baseline Scenario and Scenario 1, φ_t is entirely a lump-sum transfer (T_t). In Scenario 2, φ_t is comprised of solely capital (k_t) (our pure PVAT-K scenario). For our Scenario 3, we simulate φ_t as a 50-50 combination of lump-sum and capital. In summary, Scenarios 2 and 3 are designs where a PVAT is a crucial tool for intergenerational change by contributing to capital accumulation since a young age. Moreover, we calibrate ω_1, ω_2, and ω_3 to match the share of transfers given from the *Becas Eliza Acuña* and *Becas Benito Juarez* scholarship programs for the young cohort, the *Jovenes Construyendo el Futuro* for the adult cohort, and *Pension Para el Bienestar* for the old cohort using data from the Mexican Ministry of Finance. In the case of the PVAT reform, we eliminate the transfer to the old cohort, such that 76% of the total revenues are given to the young cohort, and 24% to the adult cohort. Finally, we calibrate the share of social transfers in revenues θ from data of the Mexican Ministry of Finance with a value of 0.25. This means 25% of the revenues are used for social transfers distributed among the young, middle-aged and the elder. The remaining share of resources represents wasteful spending in the Y sector. There are many reasons to consider wasteful spending. For example, in practice, transfer programs frequently experience inefficiencies including administrative costs (Heinrich & Brill (2015)), poor design (De Janvry & Sadoulet (2006), Baird et al. (2013)), or corruption (Tally (2011), Gaduh et al. (2023)).

Table 12: Parameter Assumptions for Mexico: High-Income Households

Parameter	Description	Scenario: Baseline	Scenario: All PVATs	Source
α_h	Share of Capital in Production	0.50	0.50	Benzell et al. (2017)
β	Time Preference	0.94	0.94	Benzell et al. (2019)
A_t	TFP of High-Income Good Y	1.00	1.00	Benzell et al. (2017)
ϕ	Share of good X in consumption	0.20	0.20	ENIGH (2018)
τ_y^h	Tax rate, High-Income Good	0.16	0.16	Ministry of Finance
τ_x^h	Tax rate, Low-Income Good	0.16	0.16	Ministry of Finance
δ_h	Depreciation Rate	1.00	1.00	Own assumption
$\bar{e}$	Rigid Endowment	0.01	0.01	ENIGH (2018)
ψ_h	Children Expenditure's Share of Income	0.05	0.05	ENIGH (2018)

Source: Authors' compilation.

Table 13: Parameter Assumptions for Mexico: Low-Income Households

Parameter	Description	Scenario: Baseline	1	2	3	Source
α_l	Share of Capital in Production	0.10	0.10	0.10	0.10	Benzell et al. (2017)
β	Time Preference	0.94	0.94	0.94	0.94	Benzell et al. (2019)
B_t	TFP of Low-Income Good X	0.46	0.46	0.46	0.46	Benzell et al. (2017)
ϕ	Share of good X in consumption	0.19	0.19	0.19	0.19	ENIGH (2018)
τ_y^l	Tax rate, High-Income Good	0.16	0.00	0.00	0.00	Ministry of Finance
τ_x^l	Tax rate, Low-Income Good	0.16	0.00	0.00	0.00	Ministry of Finance
δ_l	Depreciation Rate	1.00	1.00	1.00	1.00	Own assumption
$\bar{e}$	Rigid Endowment	0.01	0.01	0.01	0.01	ENIGH (2018)
ψ_l	Children Expenditure's Share of Income	0.08	0.08	0.08	0.08	ENIGH (2018)
φ_t	Government Transfer	T_t	T_t	k_t	T_t, k_t	Own assumption
ω_1	Share of Transfer, Young Cohort	0.41	0.41	0.76	0.41, 0.76	Ministry of Finance
ω_2	Share of Transfer, Adult Cohort	0.13	0.13	0.24	0.13, 0.24	Ministry of Finance
ω_3	Share of Transfer, Old Cohort	0.46	0.46	0.00	0.46, 0.00	Ministry of Finance
θ	Share of Transfer in Total Revenues	0.25	0.25	0.25	0.25	Ministry of Finance

Source: Authors' compilation.

Welfare Gains

We evaluate the welfare gains (W) from each PVAT reform (Scenarios 1 to 3) by computing the indirect utility of each type of household s and comparing it to the baseline. Formally,

$$\Delta W_{i,s,t+j} = V_s(P_{PVAT,i,s,t+j}) - V_s(P_{BL,i,s,t}), \tag{62}$$

where $V_s(P_{PVAT,i,s,t+j})$ is the indirect utility function evaluated at the price vector of cohort s of household z in $t+j$ periods after the PVAT reform, with $j = \{0,1,2\}$, and $V_s(P_{BL,s,z,t})$ is the indirect utility function evaluated at the price vector of cohort s of household z in [words missing?] before the policy change (period t). The price vector includes wages, the endowment, and the capital returns of cohort s. Since we are using logarithmic utility functions, $W_{s,z,t+j}$ can be interpreted as a percentage change.

Simulation Results

Figures 3-5 present the optimal simulated paths for each household type following the policy changes in the scenarios described above. Each figure includes two simulated paths–one for low-income households (represented by a solid line) and one for high-income households (represented by a dotted line). A vertical dotted line in each figure indicates the point at which the policy change takes place, making it easier to track the effects both before (*ex ante*) and after (*ex post*) the PVAT reform. All results are normalized to their baseline steady-state value. Finally, the revenue burden is conveyed as a percentage of the total cost.[38]

[38]The use of the OLG framework and the assumptions of Cobb-Douglas production and utility functions facilitate the derivation of simpler expressions. However, it should be noted that they may not fully reflect the current conditions or the

Scenario 1 (Basic PVAT-T): Generalized 16% for High-Income, 0% for Low-Income, and Lump-Sum Transfer

Figure 3 illustrates the simulated optimal paths for each type of household in Scenario 1, beginning from the baseline steady-state values, through the policy change, and ending at the new steady state. A dotted vertical line indicates the precise period when the policy shift occurs. The effects of a PVAT reform are demonstrated in Figure 3, with results indexed to their starting values to represent variations from the steady state of the baseline scenario.

Panel 3a presents the capital stocks for both low- and high-income households. With the new policy, low-income households have a zero rate in their consumption tax and receive a lump-sum transfer exclusively funded by tax collections from high-income households, thereby expanding their budget constraint. This change should, in theory, increase their savings and future capital stocks. However, these households anticipate that higher capital stocks will result in lower future returns. Similarly, high-income households foresee that an increase in savings will lead to a decrease in capital returns. In response, both households save relatively less, leading to a decrease in available capital stocks for the next period. The relative increase in consumption following policy implementation drives up prices, as shown in Panel 3b. Concurrently with the policy shift, the rise in prices also pushes wages for high-income households higher than their initial baseline values. In the same vein, the spike in prices at the time of policy implementation drives the interest rate above its initial value.

With increasing returns, household savings also expand, leading to larger capital stocks in the future. As both types of households amass a higher quantity of capital, returns on capital experience a sharp decline, as shown in Panel 3d. These new returns are sufficiently lower to discourage further savings from both types of households, thus reaching a new steady state. By the end of the transition path, savings stabilize slightly above the baseline, leading to capital stocks that are 21% higher than their initial value for low-income households, and over 15% for high-income households.

As these saving decisions come into effect, relative prices also drop to 10% lower than their initial value. The changes in both capital stocks and prices have a permanent impact on wages. Low-income households, which initially had lower wages, now see their wages increase due to higher capital stocks. On the other hand, high-income households, who initially saw a slight wage increase, now experience a decrease driven by lower prices. However, this decrease is only sufficient to bring wages slightly below their initial baseline values, around 3% under the initial value.

Lastly, Panels 3e and 3f display the revenues as a percentage of output and the fiscal burden distribution between households, respectively. In this scenario, assigning a zero-rate to low-income households results in a transfer size increase of over 1%, with the fiscal burden being completely absorbed by the high-income households.

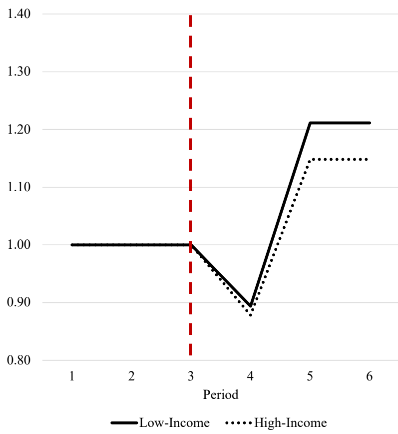
Scenario 2 (PVAT-K): Generalized 16% for High-Income, 0% for Low-Income, and Capital Transfer

What if, instead of a cash transfer, we provided a capital transfer to the low-income household? Figure 4 shows the simulated optimal paths for each household type when such a policy shift occurs. As in our previous scenario, Panel 4a presents the capital stocks for both household types. Analogous to Scenario

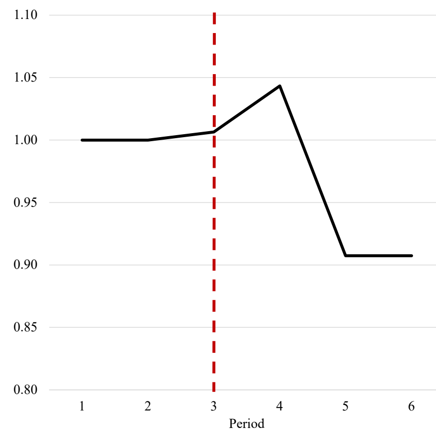
upcoming technological developments or international conditions that can influence an open economy like Mexico. Although beyond the scope of this paper, there remains the potential for a more generalized theoretical contribution as well as the possibility of expanding the simulation through a large-scale, multi-country OLG model.

Figure 3: Scenario 1: PVAT-T Reform Simulation Results (Index, 1 = Initial Baseline Steady State)

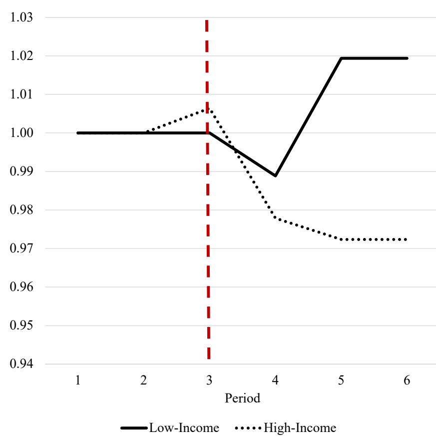
(a) Capital Stocks



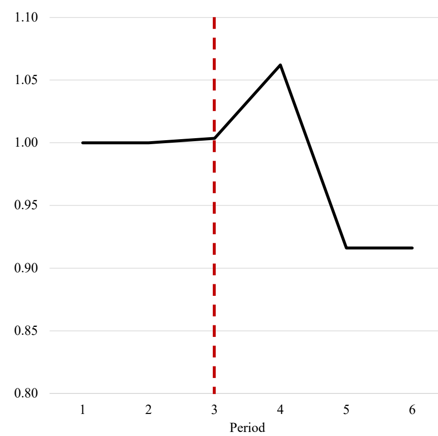
(b) Relative Price



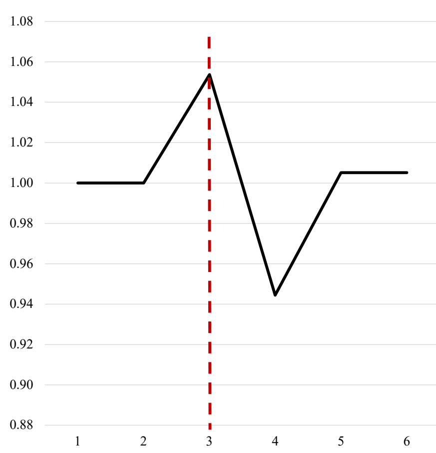
(c) Wages



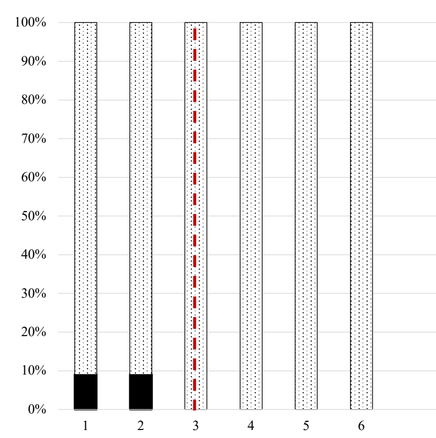
(d) Capital Returns



(e) Transfer



(f) Total Cost of Social Transfers Paid by Households (% of Total Cost)



1, both households initially opt to save less as the new tax policy alters overall consumption and savings decisions. However, the motivations for reducing savings are different in this case.

Low-income households, instead of receiving a cash transfer that would have allowed them the flexibility to both spend and save as in the previous scenario, now receive a capital transfer. This capital can only be accessed in the next period. Since this is a perfect foresight model, they anticipate that this will gradually inflate their capital stocks over time. Predicting that a sharp rise in capital stocks will trigger a fall in returns, they opt to contract their initial savings. Similarly, high-income households adjust their savings in anticipation of lower returns. In fact, to counterbalance the impacts on their future income, they decide to cut their savings by around 40%, leveraging their current resources to consume more. Consequently, prices rise almost 10% above their initial level (Panel 4b).

As both households pared down their initial savings, the subsequent period leads to higher returns. Both households will now aim to capitalize on these higher returns, opting to save more. In the long run, the high-income households and low-income households accumulate capital stocks that are, respectively, 1.45 and 1.49 times their initial amounts. Gradually, as both households contribute to a faster accumulation of capital stocks, returns converge to a new steady state that is approximately 10% below the initial value (Panel 4d).

The oscillations in savings not only influences capital stocks but also exerts effects on the demand for goods, pushing prices downward. Together, changes in prices and capital stocks alter wages (Panel 4c). Low-income households see their wages increase by over 4% compared to the baseline, a direct result of their augmented capital stocks. In contrast, high-income households experience a wage increase of about 10%, explained both by higher capital stocks and increased prices.

As in the previous scenario, the capital transfer exceeds the initial value of the lump-sum transfer (Panel 4e). However, in this scenario, the capital transfer is only marginally higher (around 1%) than the initial lump-sum transfer. Additionally, the capital transfer leads to a new equilibrium with larger capital stocks that does not overburden the high-income households when compared to their baseline capital stocks. Lastly, Panel 4f presents the distribution of fiscal burden between households. Similar to the previous scenario, the entire fiscal burden is allocated to the high-income households.

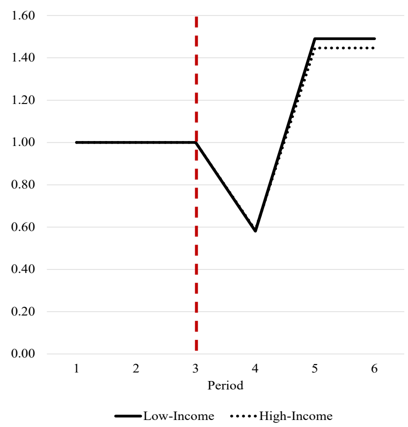
Scenario 3 (PVAT-K&T): Generalized 16% for High-Income, 0% for Low-Income, and Lump-Sum and Capital Transfer

In this scenario, we contemplate a hybrid model where the transfer to low-income households consists of both a lump-sum component and a capital component, each constituting 50% of the total transfer. While the lump-sum component can be utilized for immediate consumption or savings, the capital transfer is only redeemable in the subsequent period. Figure 5 presents the simulated optimal paths for each type of household once that policy change is implemented.

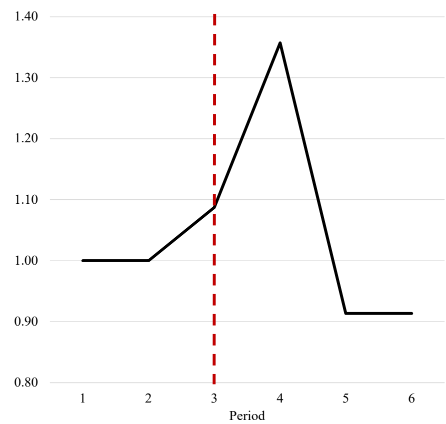
In a similar vein to the previous PVAT-K scenario, low-income households accumulate a significant amount of capital following the new policy. Conversely, high-income households decrease their savings in favor of consumption, anticipating future drops in capital returns. However, the net effect on prices is negative, as the increase in savings from low-income households counteracts the rise in consumption by high-income households (Panel 5b), resulting in an overall 14% drop in relative prices. As a consequence, and consistent with the PVAT-K scenario, the period following the policy change sees the capital stocks of low-income households increase significantly, contributing to a decrease in capital returns (Panel 5d). In contrast, the fall in capital stocks experienced by high-income households contributes in the opposite direction. These

Figure 4: Scenario 2: PVAT-K Reform Simulation Results (Index, 1 = Initial Baseline Steady State)

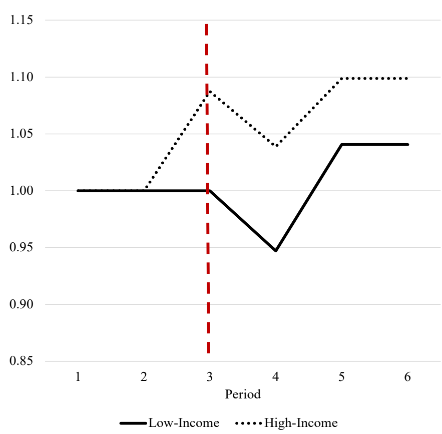
(a) Capital Stocks



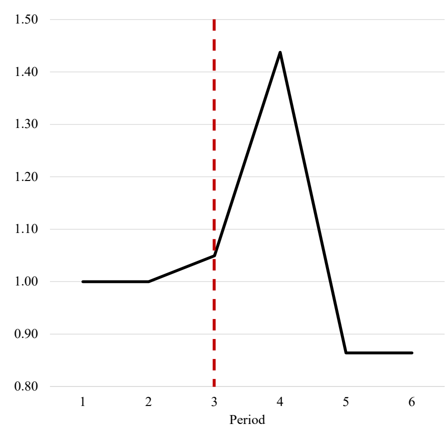
(b) Relative Price



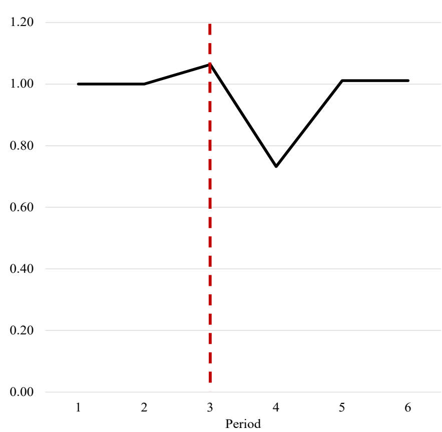
(c) Wages



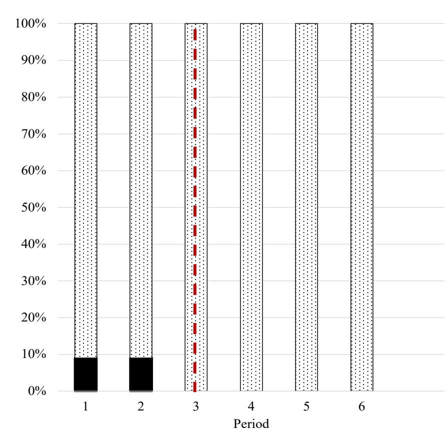
(d) Capital Returns



(e) Transfer



(f) Total Cost of Social Transfers Paid by Households (% of Total Cost)



factors set off similar dynamic effects as in the PVAT-K scenario, albeit with varying intensity.

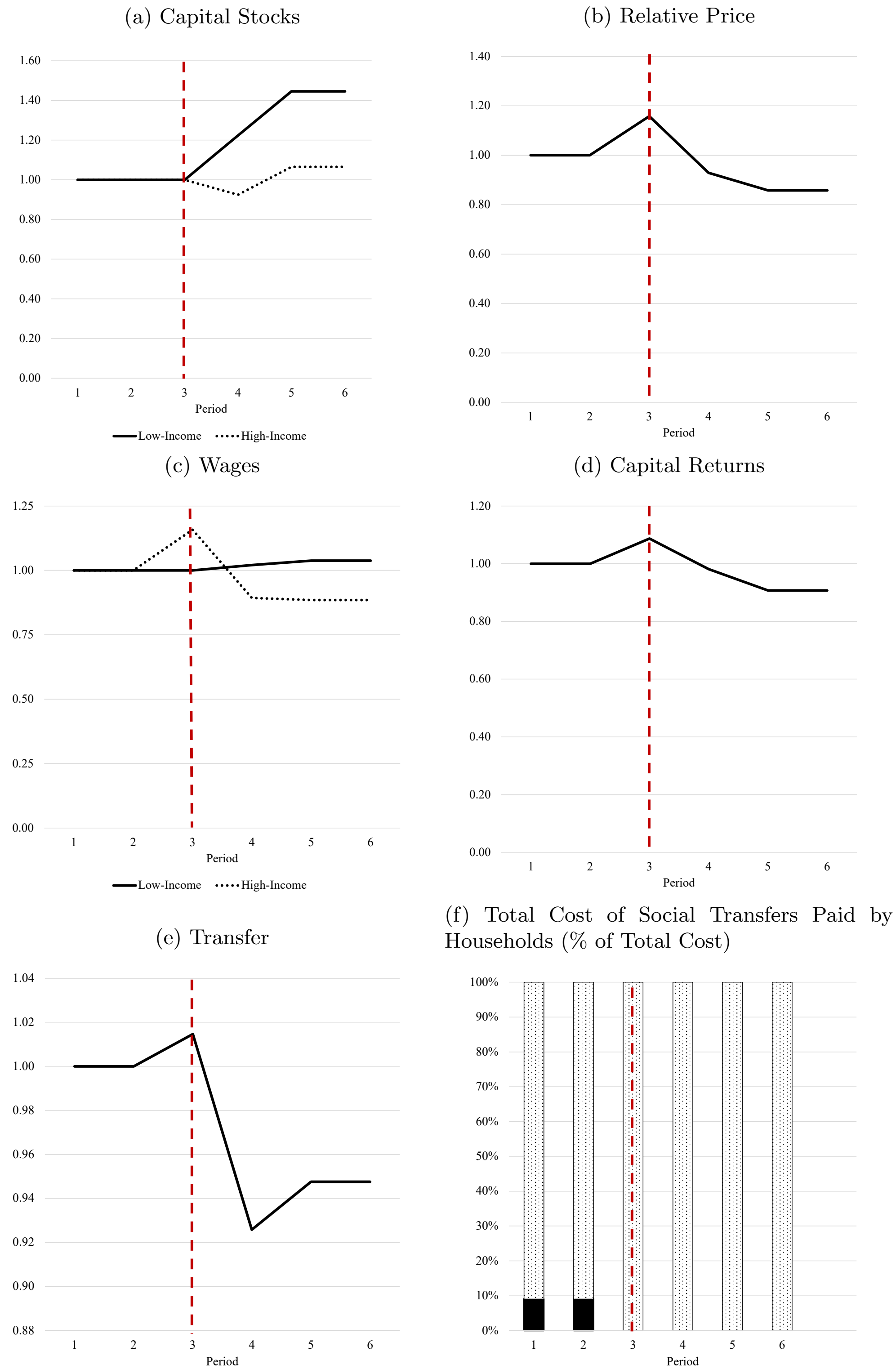
The main divergence between these two scenarios can be primarily attributed to the behavior of the low-income household. As the younger generation receives a lump-sum transfer along with a promise of a capital transfer upon reaching adulthood, they are likely to slightly increase both current consumption and savings. Although the capital accumulation immediately after the policy change is less than in the previous scenario, high-income households anticipate a lower rate of return on capital and adjust their consumption-saving behavior accordingly. Prices adjust in response, and in conjunction with the dynamics of capital stocks, the wages of high-income households fall 13% relative to the initial value. On the other hand, the increased capital stocks for low-income households drive their wages slightly above their initial value.

Upon the completion of the transition period, low-income and high-income households have amassed capital 1.45 and 1.07 times their initial baseline, respectively. In terms of wage levels, low-income households stabilize at a level 2% higher than the baseline, while high-income households arrive at a wage level 11% lower than the baseline. Capital returns are not significantly impacted by this new policy, ending up just 9% lower than the baseline.

This scenario shares traits with the previous scenarios (Lump-sum and PVAT-K). In this case, however, the effects from the lump-sum component are more dominant. Despite the transfer not being entirely lump-sum, it still disturbs the capital market. As a result, high-income households find their lifetime income penalized due to lower capital returns. Thus, a key takeaway from this scenario is that it yields better outcomes for the low-income household in terms of relative capital wealth compared to the initial values.

From a policymaker's standpoint, this presents a dilemma. If only a lump-sum transfer is provided, it would distort consumption and savings in a negative way for high-income households. However, capital transfers at least result in improvements to the labor income of both households. Consequently, the policy-maker must decide whether they place greater importance on present consumption or medium to long-term consumption.

Figure 5: Scenario 3: Hybrid PVAT Reform Simulation Results (Index, 1 = Initial Baseline Steady State)



We evaluate welfare shifts to discern how different cohorts are impacted across various scenarios. Tables 14 and 15 present the variations in lifetime utility for our primary scenarios. The changes in welfare are computed as detailed in our welfare gains subsection and are displayed as a percentage deviation from the baseline. For every scenario, the tables include a column representing the lifetime welfare changes for the cohorts alive at the time of the policy's implementation. In a subsequent column, the tables reflect the lifetime utility of these cohorts once the economy settles into a new steady state.

Table 14: Life-Time Welfare Changes (% change)

Cohort	Scenario 1		PVAT-K	
	Start of the Policy	New S.S	Start of the Policy	New S.S
Young - Low	1.16	0.71	1.18	0.74
Adult - Low	0.29	1.12	0.26	1.07
Old - Low	0.16	1.16	-0.05	1.18
Young - High	0.05	0.05	-1.94	0.03
Adult - High	-0.90	0.13	-2.23	-0.03
Old - High	0.01	0.05	0.00	-1.94
Total Welfare Change	-0.03	0.35	-0.83	-0.15
Total Change in Output	0.00	5.23	-4.41	9.07

Source: Own elaboration using simulation results.

The initial two columns of Table 14 correspond to the PVAT-T scenario. Firstly, we assess the welfare gains (or losses) for the different low-income cohorts present during the implementation of the new policy. Under this scenario, low-income households encounter a 0% VAT rate and a lump-sum transfer, which influences their consumption-saving decisions and, therefore, their lifetime welfare. Both young and adult cohorts find it optimal to initially decrease savings and increase them later. Older cohorts, not subject to saving decisions, can fully appreciate lower taxes and transfers, despite facing higher prices. Collectively, they experience a welfare enhancement of 0.16% relative to the baseline steady state. In contrast, adults witness a 0.29% surge in their lifetime well-being, driven by an increase in disposable income and the higher government transfer. The young cohort, being the first to enjoy a zero-rated VAT coupled with government transfers throughout their lifetime, benefits the most. They undergo a 1.16% welfare improvement over their lives. This increase stems from both the immediate and long-term effects of the new policy. Initially, the young cohort transitions into adulthood with lower capital stocks, resulting in implicitly lower salaries. These are somewhat counterbalanced by higher rates of return on their capital stocks. Subsequently, capital accumulation propels wages above their baseline value.

In the second column, we illustrate the changes in welfare compared to the baseline scenario once the economy has achieved its new steady state. From this point forward, all cohorts will experience welfare outcomes superior to the previous steady state. This improvement is propelled by their lifetime's higher accumulation of capital, a marginally increased transfer size, and an augmented disposable income resulting from the PVAT reform. The young cohort present at this time achieves a lifetime welfare increase of 0.71% compared to the baseline. When the model arrives at the new steady state, the adult cohort will have experienced an overall welfare enhancement of 1.12% above the baseline, driven by their larger capital accumulation. Lastly, the older cohort in the new steady state, which is the same as the young cohort at the policy's initiation, will see a welfare increase of 1.16%.

The welfare trajectory for high-income households does not fare as well as that of low-income households. For instance, the young high-income cohort present at the implementation of the PVAT-T reform achieves a marginal improvement of 0.05%. This outcome arises from an initial reduction in savings that subsequently impacts their lifetime wages, while their returns on capital are not sufficient to yield better results. The adult high-income cohort is the most impacted by the policy change, with a decrease in welfare of approximately 0.9% compared to the initial steady state. This effect is predominantly driven by lower capital income, a consequence of their initial decision to diminish savings. Finally, the older high-income cohort alive at the time of policy reform experiences a negligible increase in welfare (0.01%). This arises from higher returns on their current capital stocks, counterbalanced by the effect of higher prices.

Once the economy reaches a new steady state, the high-income household experiences a positive lifetime welfare increase of 0.13%, attributable to their ability to accumulate a larger stock of capital that ultimately outweighs the lower returns in their later years. From then on, newer generations will have a lifetime welfare 0.05% above the young's initial steady state.

Columns 3 and 4 of Table 14 display the results of the PVAT-K scenario, which involves a 100% capital transfer to the young and adult cohorts. According to our simulation, under the PVAT-K reform, only the young and adult low-income households present at the time of implementation will experience an improvement in welfare, specifically, 1.18% and 0.26% above the initial steady state, respectively. Initially, both these groups benefit from a zero-rated VAT and the assurance of receiving a capital transfer in their subsequent life stages. The adult group will witness increased capital returns on their existing stocks. Conversely, the older generation will encounter higher returns but also higher prices. Moreover, as they no longer receive any form of government support, their welfare will be 0.05% below the baseline steady state.

In the PVAT-K scenario, high-income households are the ones who bear the brunt of the change. The cohorts alive at the time of the policy shift will be influenced by fluctuations in capital stocks. For instance, the young cohort will transition to adulthood with lower capital stocks, which will be largely counterbalanced by a sharp rise in returns. However, their capital income will not see an improvement. On the other hand, their labor income will increase, but they will also have to contend with significantly higher prices. Collectively, these factors will lead to a reduction in their welfare by 1.9%. The adult cohort, present at the time of the reform, will grapple with higher prices and a decrease in their savings, which will impact their future consumption. Consequently, their lifetime welfare will be the most significantly affected by the PVAT-K reform, resulting in a decrease of 2.2%.

When the economy eventually stabilizes in a new steady state, all low-income households, along with the young high-income cohort, will witness improvements in welfare. This outcome is primarily driven by an increase in capital stocks across both high- and low-income households, which acts as a major catalyst for the boost in labor income. Even though capital returns may decline, their long-term capital income will be higher, yielding benefits for all households in the economy. In summary, the PVAT-K reform appears to deliver marginally better results for low-income households compared to the PVAT-T scenario. However, given that high-income households are more reliant on capital income than labor income, the PVAT-K reform significantly impacts them due to its substantial effects on capital markets.

These findings might suggest that a PVAT-T policy is adequately progressive in terms of both static (tax schedule) and intergenerational aspects. However, when contemplating the potential of merging the PVAT progressive tax schedule with capital transfers, both households and the broader economy could experience more profound structural shifts. Nevertheless, the gains accrued by low-income households through these structural changes come at the cost of the welfare of high-income households.[39] Determining whether the welfare loss experienced by high-income households is tolerable for the overall economy necessitates evaluating other outcomes, such as total output. Under the PVAT-T policy, total output initially remains unchanged with 0%, eventually leading to a 5.23% increase from the initial steady state. In contrast, with the PVAT-K scenario, total output decreases by almost 4.5%, eventually overshooting to reach an approximately 9.1% increase above the initial steady state. The PVAT-K scenario suggests that in the long run output growth will be accompanied with welfare improvements mainly for the low-income households. In contrast, under the the PVAT-T, output growth coexists with outcomes benefiting both high and low-income households.

Is it possible to devise a PVAT progressive schedule that not only promotes intergenerational objectives but also minimizes welfare loss? Table 15 presents three variations of PVAT reforms that combine lump-sum and capital transfers. The first two columns pertain to a scenario where the government's transfer consists of 75% capital and 25% lump-sum. The subsequent four columns depict cases for a 50-50 (corresponds to Scenario 3 simulation) and 25-75 distribution, respectively. As we progress further to the right of the table, we should anticipate welfare outcomes that resemble the PVAT-T scenario. Conversely, moving to the left aligns the scenario more closely with the PVAT-K reform.

Table 15: Scenario 3: PVAT with T & K Transfers

	Scenario 3 (k,t)					
Cohort	(0.75, 0.25)		(0.50, 0.50)		(0.25, 0.75)	
	Start of the Policy	New S.S	Start of the Policy	New S.S	Start of the Policy	New S.S
Young - Low	0.70	0.80	0.83	0.72	1.16	0.73
Adult - Low	0.41	1.08	0.31	1.09	0.29	1.16
Old - Low	0.29	0.70	0.18	0.83	0.15	1.16
Young - High	-0.27	-0.16	-0.12	-0.04	0.01	0.03
Adult - High	-0.07	-0.19	-0.13	0.02	-0.89	0.12
Old - High	-0.03	-0.27	0.00	-0.12	0.01	0.01
Total Welfare Change	0.05	0.11	0.07	0.23	-0.04	0.34
Total Change in Output	0.05	1.76	0.05	2.83	0.05	6.27

Source: Own elaboration using simulation results.

The outputs from the above scenarios are effects outlined in Table 15 show the welfare outputs for the above scenarios comprising a combinations of our PVAT-T and PVAT-K cases. In all three variations of Scenario 3, low-income households experience a welfare gain, while high-income households face some level of detriment due to the PVAT reform. Over the long term, the effects differ depending on the distribution between capital and lump-sum transfers.

In low-income households, the configuration of 75% capital and 25% lump-sum results in a new long-run steady state increase of 0.80% for all the new (young) cohorts. This welfare outcome turns out to be the highest across all scenario 3 specifications for future new generations. This result stems from greater capital accumulation and lower relative prices. In contrast, the 50-50 and 25-75 scenarios yield welfare increases for the future new (young) cohorts of 0.72% and 0.73%, respectively. The main differences, of course, stem from the different degree of capital accumulation and the final level of relative prices. Yet, the 50-50 and 25-75 scenarios deliver higher transitional welfare than the 75-25 case, with the adult and old cohorts of the low-income bracket experiencing superior welfare gains. For high-income households, all scenarios penalize their future cohorts except under the the 25-75 case. These differences are mainly due to lower relative prices affecting capital differently their capital income. On the other hand, once we turn our attention to output

[39] Let us recall that, in our model, the inclusion of capital serves as a simplistic representation of any production factor different from labor that contributes to the enhancement of labor's marginal productivity and/or capital accumulation.

growth we can observe several alternatives for policy decisions. Under the 25-75 case, output growth is the largest among the other variations of scenario 3 even above growth under the PVAT-T scenario. Moreover, the 25-75 case results in overall welfare gains of about 0.73% for all new low-income generations and mostly unchanged welfare for high-income new generations (0.03%).

The significance of the policymaker's prioritization of various cohorts and households cannot be overstated. The PVAT stands as a fiscal policy tool possessing considerable potential to foster structural advancement over time for low-income households. While the PVAT-K distributional design aids low-income households at the expense of the high-income group, it simultaneously bolsters the economy as it approaches a new steady state. When pursuing the ideal mix between capital and lump-sum transfers, we should be aware that long-run outcomes are non-linear. However, PVAT configurations that align more closely with the PVAT-T model yield superior outcomes for high-income transitional generations. Conversely, designs that bear greater resemblance to the PVAT-K model offer worse outcomes in the long run for high-income households. Such results highlight the importance of short to medium-term considerations and the weight that policymakers gives to each of them. Therefore, a policymaker contemplating any PVAT reform would need to determine whether to prioritize current or future consumption of households. In conclusion, irrespective of these preferences, the insights garnered from this section imply that the ideal PVAT reform should strategically integrate a mix of lump-sum and capital transfers. This approach would allow for the attainment of both tax progressivity and intergenerational equity.

Conclusion and Final Remarks

VAT systems in numerous countries feature special provisions to assist the underprivileged, with zero-rated food and medicine being the most common. Consequently, any reform deviating from this arrangement would require compelling reasons to alter the status quo. Acknowledging this, our paper introduces a Personalized VAT (PVAT) aimed at achieving three objectives: increasing revenue collection, progressively impacting wealthier households, and enhancing the inter-generational welfare of low-income families. Our PVAT concept strives to enhance both absolute and relative progressivity while also yielding additional revenues from businesses and higher-income households. We leverage initial work in Barreix et al. (2012) and Barreix et al. (2022) to fortify this concept, permitting specific VAT rates based on a progressive rule, even when it involves a negative tax. We recommend implementing a capital transfer, termed PVAT-K, as a key part of a comprehensive PVAT policy. This approach could potentially disrupt inter-generational dependency without penalizing the poor or draining fiscal revenues.

We base our study on the Mexican VAT system, known for its inefficiencies since its inception in the 1980s. Despite numerous attempts to enhance it, the central issue of boosting revenue collection without negatively impacting lower-income households remains unsolved. Our analysis, utilizing national accounting, indicates that transitioning from special regimes to a generalized VAT could elevate revenues by over 2% of GDP. However, this comes with a hefty price tag, as it would significantly increase the burden on lower-income deciles. We qualitatively demonstrate that various PVAT scenarios could potentially ensure progressivity alongside additional revenue collection. Even after conducting standard incidence analysis, we ascertain that a PVAT with negative VAT rates for lower-income deciles could at least be revenue neutral. In fact, if all current fragmented social transfers were replaced by a single PVAT transfer equal to the poverty line, net fiscal revenues would be positive. Lastly, we examine PVAT capital transfers using Overlapping Generations (OLG) general equilibrium simulations, which suggest that such designs could potentially disrupt intergenerational dependency.

So, is a PVAT implementation feasible? Taking Mexico as a case study, launching a personalized VAT reform does not appear to be an insurmountable challenge. Since 2017, the Tax Administration Service (SAT) of Mexico has significantly upgraded its technological infrastructure and database systems. Today, there is almost direct connectivity with Point of Sale (POS) terminals, facilitating the creation of e-invoices with a single card swipe. This technology could be utilized at the point of transaction to identify if one's Tax Identification Code (RFC) or Personal Identification Number (CURP) aligns with a PVAT bracket. However, this would require mapping the RFC/CURP to specific income categories, a task that poses challenges not only in Mexico but also in any developing country due to widespread informality. Nevertheless, Mexico could introduce such a reform in a phased manner. For instance, the registry of unconditional transfer beneficiaries, who receive funds via debit cards, could be leveraged to apply a PVAT rate of zero or an equivalent transfer (lump-sum component) to ensure their rise above the poverty line. For capital transfers, Mexico could employ the State-Owned Pension Fund Administrator (PENSIONISSSTE) as the financial intermediary to manage these capital accounts. The remaining population could be subject to a standard rate of, say, 16%. Over time, the SAT could use electronic invoice and tax declaration data to dynamically allocate individual-specific PVAT rates. In cases where this information is not available, the standard rate would apply. A gradual implementation of this policy could lead to substantial secondary benefits. For example, if the standard rate were high, say 20%, and could only be reduced through tax declarations and electronic invoices when purchasing via electronic means, it would encourage both banking and formal employment. Another hurdle for successful PVAT reform is the accurate accounting of individual income, such as those receiving domestic or foreign dividends. To overcome this issue, a more cohesive integration of individual records by fiscal authorities and financial institutions would be needed.

Certainly, the implementation of e-invoicing has led to overall improvements in technological capabilities in SAT. However, there are still significant gaps that need to be addressed before intelligent digital analysis can be widely utilized to identify income groups on a large scale. Consequently, the feasibility of K transfers, taking into account the taxpayer's characteristics (such as their income profile, including the income decile, or specific attributes like employment status or retirement) through digital methods like cards or mobile transfers will depend on the level of maturity SAT achieves in the upcoming years. Moreover, it is crucial to consider the overall benefits of a reform like PVAT-K while ensuring that appropriate incentives are in place to encourage citizens to maintain or transition into formalized economic activities.

In conclusion, while endorsing a reform that universalizes VAT can be challenging, negotiating a PVAT-style reform is likely to be less daunting. A PVAT serves as a dynamic instrument of both transfer and taxation, designed to ensure that wealthier households contribute to the transfers that enable low-income families to break free from the shackles of social stagnation.

References

Abramovsky, L., Attanasio, O., Emmerson, C., & Phillips, D. (2011). The distributional impact of reforms to direct and indirect tax in mexico: Analytical report and results.

Abramovsky, L., Attanasio, O., Emmerson, C., Phillips, D., & Paez, H. J. V. (2010). The distributional impact of reforms to direct and indirect tax in mexico: Methodological issues and approach.

Abramovsky, L., & Phillips, D. (2015). *A tax micro-simulator for mexico (mextax) and its application to the 2010 tax reforms* (Tech. Rep.). IFS Working Papers.

Ainsworth, R. T. (2005). The digital vat (d-vat). *Va. Tax Rev.*, *25*, 875.

Auerbach, A. J., & Kotlikoff, L. J. (1987). Evaluating fiscal policy with a dynamic simulation model. *The American Economic Review*, *77*(2), 49–55.

Ayllon-Aragon, G., Fuentes-Castro, H., Ruiz-Jimenez, C., & Zamudio-Carrillo, A. (2018). *Evasion en actividades profesionales* (Tech. Rep.). Sistema de Administracion Tributaria y Tec de Monterrey.

Bachas, P., Gadenne, L., & Jensen, A. (2020). *Informality, consumption taxes, and redistribution* (Tech. Rep.). National Bureau of Economic Research.

Baird, S., Ferreira, F. H., Özler, B., & Woolcock, M. (2013). Relative effectiveness of conditional and unconditional cash transfers for schooling outcomes in developing countries: a systematic review. *Campbell systematic reviews*, *9*(1), 1–124.

Banks, J., Blundell, R., & Lewbel, A. (1997). Quadratic engel curves and consumer demand. *Review of Economics and statistics*, *79*(4), 527–539.

Barreix, A., Bès, M., & Roca, J. (2012). Resolviendo la trinidad imposible de los impuestos al consumo: El iva personalizado. *En: Reforma fiscal en América Latina:¿ qué fiscalidad para qué desarrollo?. Santiago: CEPAL; Fundación CIDOB, 2012. LC/L. 3522. p. 49-77*.

Barreix, A., Bès, M., Roca, J., Fonseca, O., Fontenez, M., Moran, D., & Pineda, E. (2022). El iva personalizado revisado: una herramienta para la consolidación fiscal con equidad. *Documento de Discusion IDB-DP-939*.

Benedek, M. D., De Mooij, R. A., & Wingender, M. P. (2015). *Estimating vat pass through.* International Monetary Fund.

Benzell, S. G., Kotlikoff, Lagarda, L., et al. (2019). Macroeconomic effects of reducing oasi benefits: A comparison of seven overlapping-generations models. *National Tax Journal*, *72*(4), 671–692.

Benzell, S. G., Kotlikoff, L. J., & LaGarda, G. (2017). *Simulating business cash flow taxation: An illustration based on the "better way" corporate tax reform* (Tech. Rep.). National Bureau of Economic Research.

Benzell, S. G., Kotlikoff, L. J., LaGarda, G., & Ye, V. Y. (2021). *Simulating endogenous global automation* (Tech. Rep.). National Bureau of Economic Research.

Bosch, M., Stampini, M., & Bedoya, G. (2012). Are conditional cash transfers associated with lower labor supply?: Evidence from mexico's oportunidades over the period 2000-2010.

Burbidge, J. B. (1983). Social security and savings plans in overlapping-generations models. *Journal of Public Economics*, *21*(1), 79–92.

Deaton, A., & Muellbauer, J. (1980). An almost ideal demand system. *The American economic review*, *70*(3), 312–326.

De Janvry, A., & Sadoulet, E. (2006). Making conditional cash transfer programs more efficient: designing for maximum effect of the conditionality. *The World Bank Economic Review*, *20*(1), 1–29.

Ebrill, M. L. P., Keen, M. M., & Perry, M. V. P. (2001). *The modern vat.* International Monetary Fund.

Emran, M. S., & Stiglitz, J. E. (2005). On selective indirect tax reform in developing countries. *Journal of public Economics*, *89*(4), 599–623.

Engstrom, R., Hersh, J., & Newhouse, D. (2022). Poverty from space: Using high resolution satellite imagery for estimating economic well-being. *The World Bank Economic Review*, *36*(2), 382–412.

Gaduh, A., Hanna, R., & Olken, B. A. (2023). *The marginal disutility from corruption in social programs: Evidence from program administrators and beneficiaries* (Tech. Rep.). National Bureau of Economic Research.

Green, R., & Alston, J. M. (1990). Elasticities in aids models. *American Journal of Agricultural Economics*, *72*(2), 442–445.

Heinrich, C. J., & Brill, R. (2015). Stopped in the name of the law: Administrative burden and its implications for cash transfer program effectiveness. *World Development*, *72*, 277–295.

Hersh, J., Engstrom, R., & Mann, M. (2021). Open data for algorithms: mapping poverty in belize using open satellite derived features and machine learning. *Information Technology for Development*, *27*(2), 263–292.

Holỳ, V., & Šafr, K. (2017). Disaggregating input-output tables by the multidimensional ras method. *arXiv preprint arXiv:1704.07814*.

Keen, M. (2008). Vat, tariffs, and withholding: Border taxes and informality in developing countries. *Journal of Public Economics*, *92*(10-11), 1892–1906.

Keen, M., & Lockwood, B. (2010). The value added tax: Its causes and consequences. *Journal of Development Economics*, *92*(2), 138–151.

Kotlikoff, L. J., Smetters, K., & Walliser, J. (1998). *Social security: privatization and progressivity.* National Bureau of Economic Research Cambridge, Mass., USA.

Lahey, K. (2018). Gender, taxation and equality in developing countries: Issues and policy recommendations. *UN Women*.

Levenberg, K. (1944). A method for the solution of certain non-linear problems in least squares. *Quarterly of applied mathematics*, *2*(2), 164–168.

Marquardt, D. W. (1963). An algorithm for least-squares estimation of nonlinear parameters. *Journal of the society for Industrial and Applied Mathematics*, *11*(2), 431–441.

Matheson, T., & Swistak, A. (2014). *Modernizing the icelandic vat* (Tech. Rep.). IMF Country Report No. 14/291.

OECD. (2023). *Oecd tax database.* Retrieved from https://www.oecd.org/tax/tax-policy/tax-database/

Oropeza, E., & Lagarda, G. (2020). *Conformacion de una sam para mexico usando cou* (Tech. Rep.). GDPC Working Paper Series.

Reinsberg, B., Stubbs, T., & Kentikelenis, A. (2020). Taxing the people, not trade: The international monetary fund and the structure of taxation in developing countries. *Studies in Comparative International Development*, *55*(3), 278–304.

Świstak, A., Wawrzak, S., & Alińska, A. (2015). In pursuit of tax equity: lessons from vat rate structure adjustment in poland. *Financial theory and practice*, *39*(2), 115–137.

Tait, M. A. A. (1988). *Value added tax: International practice and problems.* International Monetary Fund.

Tally, E. (2011). Corruption in conditional cash transfer programs cctps. policy implications from an actor based analysis of the cctp mi familia progresa in guatemala.

Temursho, U., Oosterhaven, J., & Cardenete, M. A. (2021). A multi-regional generalized ras updating technique. *Spatial Economic Analysis*, *16*(3), 271–286.

Urzúa, C. M. (2001). Welfare consequences of a recent tax reform in mexico. *Estudios Económicos*, 57–72.

Appendices

A Methodology: Estimating Forgone VAT Revenues from the Economy

In order to construct an updated version of the I-O matrix we used the Supply and Utilization Tables (SUT), SNA with detailed data for 2018. We follow the methodology as in Holỳ & Šafr (2017), Oropeza & Lagarda (2020), and Temursho et al. (2021). Moreover, whenever needed, we used information from the Economic Census.

Using the newly updated I-O matrix, we proceed to compute the forgone revenues due to the 0% VAT. Tax expenditures are defined as in Barreix et al. (2022). Because INEGI's SNA only has information of intermediate demand at 2-digit (NAICS), we assume that the proportion that of the total food sector represented by processed foods remained constant for the last 4 years. The same same applied to bottled water, and medicines vis-a-vis their respective sector. These shares ($s_{i,t}$) are implicitly embedded in the structure of the I-O matrix. Therefore, our proxy for intermediate demand of product i is obtained by multiplying this share times their respective total intermediate demand $D_{I,t}^{\text{int}}$:

$$D_{i,t}^{\text{int}} = s_{i,t}^{\text{int}} D_{I,t}^{\text{total}}, \tag{63}$$

where

$$s_{i,t}^{\text{int}} = \frac{D_{i,t}^{\text{int}}}{D_{I,t}^{\text{int}}}. \tag{64}$$

For public sector drugs and medicines intermediate demand we use SHCP information about medicine expenditures in the Health Ministry, PEMEX Hospitals, IMSS, ISSSTE and the Mexican Military (FAM). Therefore, we define public sector health expenditure H_t as:

$$H_t = {h_t}^{\text{IMSS}} + {h_t}^{\text{ISSTE}} + {h_t}^{\text{FAM}} + {h_t}^{\text{PEMEX}} + {h_t}^{\text{SSA}}. \tag{65}$$

Finally, total consumption is the sum of both final demand and intermediate demand minus the exports.

$$C_{i,t}^{\text{total}} = C_{i,t}^{f} + {C_{i,t}}^{\text{int}} - X_{i,t}. \tag{66}$$

B Personalized VAT: Barreix et al. (2022)

Prior research has explored the concept of personalized value added taxation. Barreix et al. (2022), building on the work of Barreix et al. (2012), attempted to quantify the potential revenue from a PVAT reform, discounting general equilibrium effects, in countries such as Argentina, Costa Rica, Dominican Republic, and Uruguay. The results from Scenario 1 in Barreix et al. (2022) are displayed in Table 16. This scenario involves eliminating the zero-rated tax frameworks, implementing a universal statutory tax rate for each country, and providing a government transfer to the lowest three income deciles that more than compensates for the incurred tax burden. For instance, in Argentina, Barreix et al. (2022) applied a uniform rate of 21% to previously zero-rated goods and offset the tax burden with a transfer to the lowest three income deciles. This scenario parallels our Scenario 4 displayed in Table 10.

Table 16: VAT Burden by Income Decile (% of Income, unless otherwise specified)

Decile	Argentina (2018)		Costa Rica (2018)		Dominican Rep. (2018)		Uruguay (2018)	
	Actual	PVAT	Actual	PVAT	Actual	PVAT	Actual	PVAT
1	14.9	12.0	14.6	7.3	5.5	2.8	10.0	9.6
2	12.1	11.0	9.7	6.6	4.4	3.3	8.7	8.7
3	11.1	10.7	9.4	7.8	3.8	3.7	8.7	8.7
4	10.6	10.6	9.3	16.2	3.8	3.8	9.2	10.6
5	10.3	12.2	8.7	15.1	3.4	6.6	8.2	9.5
6	9.7	11.7	8.8	14.7	3.3	6.2	8.5	9.8
7	9.4	11.3	8.7	14.3	3.3	5.7	8.4	9.6
8	9.4	11.2	7.7	12.2	3.0	5.2	8.5	9.6
9	9.0	10.8	8.6	12.8	2.8	4.5	8.0	9.1
10	7.5	9.1	7.5	10.2	2.1	3.2	7.3	8.2
Total Revenue (% GDP)	9.1	10.5	8.4	12.0	2.9	4.3	8.3	9.2
Change in Revenue		0.8		1.8		1.3		0.6
Statutory Tax Rate	21%	21%	13%	13%	18%	18%	22%	22%

Source: Barreix et al. (2022).

C Statistical Tables

Our statistical tables include some summary statistics for each of the five groupings used in the QUAIDS estimation per decile, the associated income, own price, and cross-price elasticities of each grouping per decile, and the regression outputs of the SURE estimation. Furthermore, we include as an interesting exercise the separation of foregone revenues from zero-rated foods and services separating by NAICS classification (using ENIGH and I-O Matrix). For the sake of brevity, only the estimated elasticities and SURE outputs are shown, but all the remaining tables are available upon request by emailing gmarinmunoz@iadb.org.

Table 17: QUAIDS Estimation by Income Decile

	Income Decile									
Coefficient	I	II	III	IV	V	VI	VII	VIII	IX	X
α_1	-0.8388***	-0.5764***	-0.9332***	-0.7473***	-0.6833***	-0.1239	-0.2914	-0.3858	-0.3555*	-0.0177
	(0.1189)	(0.1690)	(0.1243)	(0.1313)	(0.2528)	(0.3074)	(0.2577)	(0.2503)	(0.2123)	(0.0612)
β_1	0.0099***	0.0644***	0.0085***	0.0101***	0.0338**	0.0787***	0.0745***	0.0381***	0.0423***	0.0450***
	(0.0016)	(0.0172)	(0.0012)	(0.0031)	(0.0144)	(0.0152)	(0.0131)	(0.0099)	(0.0131)	(0.0050)
γ_{11}	-0.3712***	-0.4252***	-0.3967***	-0.3561***	-0.3971***	-0.3906***	-0.3864***	-0.3471***	-0.3202***	-0.1725***
	(0.0390)	(0.0399)	(0.0380)	(0.0444)	(0.0489)	(0.0476)	(0.0478)	(0.0470)	(0.0195)	(0.0077)
γ_{12}	0.1931***	0.2303***	0.2182***	0.1966***	0.1821***	0.1821***	0.1632***	0.1572***	0.1432***	0.0795***
	(0.0312)	(0.0484)	(0.0376)	(0.0350)	(0.0403)	(0.0408)	(0.0251)	(0.0358)	(0.0257)	(0.0185)
γ_{14}	-0.0150***	-0.0127***	-0.0214***	-0.0110***	-0.0126**	-0.0104***	-0.0091**	-0.0102***	-0.0096***	-0.0074***
	(0.0039)	(0.0043)	(0.0043)	(0.0029)	(0.0052)	(0.0017)	(0.0039)	(0.0036)	(0.0018)	(0.0020)
γ_{15}	0.1090***	0.0913***	0.0900**	0.0699**	0.1217**	0.1204***	0.1311**	0.0989**	0.1345***	0.1043***
	(0.0272)	(0.0288)	(0.0364)	(0.0325)	(0.0480)	(0.0367)	(0.0518)	(0.0448)	(0.0214)	(0.0137)
α_2	0.4036**	0.5895***	0.5055***	0.4280***	0.3498***	0.4177***	0.3799***	0.2276*	0.1873***	0.2922***
	(0.1724)	(0.1723)	(0.1202)	(0.0965)	(0.1252)	(0.1339)	(0.0775)	(0.1322)	(0.0503)	(0.0529)
β_2	-0.0333***	-0.0216***	-0.0227***	-0.0274***	-0.0271***	-0.0188***	-0.0201***	-0.0298***	-0.0248***	-0.0051**
	(0.0123)	(0.0073)	(0.0070)	(0.0076)	(0.0048)	(0.0071)	(0.0057)	(0.0064)	(0.0060)	(0.0023)
γ_{22}	-0.0281***	-0.0213**	-0.0219**	-0.0207*	-0.0169**	-0.0256**	-0.0129	-0.0110	-0.0138	-0.0098
	(0.0108)	(0.0105)	(0.0103)	(0.0108)	(0.0086)	(0.0126)	(0.0136)	(0.0107)	(0.0107)	(0.0089)
γ_{24}	0.0013	0.0036**	0.0022	0.0001	0.0009	0.0023*	0.0003	0.0022*	0.0008	0.0000
	(0.0023)	(0.0016)	(0.0015)	(0.0009)	(0.0010)	(0.0012)	(0.0011)	(0.0013)	(0.0008)	(0.0009)
γ_{25}	-0.0981***	-0.1297***	-0.1163***	-0.1130***	-0.1015***	-0.1021***	-0.0945***	-0.0989***	-0.0776***	-0.0515***
	(0.0260)	(0.0246)	(0.0163)	(0.0157)	(0.0210)	(0.0203)	(0.0120)	(0.0175)	(0.0081)	(0.0117)
α_4	-0.0201	-0.0176	0.0153	-0.0101	0.0185	0.0214	0.0384***	-0.0015	-0.0098	0.0370*
	(0.0150)	(0.0203)	(0.0215)	(0.0118)	(0.0153)	(0.0204)	(0.0133)	(0.0100)	(0.0073)	(0.0223)
β_4	0.0004**	-0.0003	0.0055**	-0.0001	0.0038**	0.0035*	0.0044***	0.0002	0.0001	0.0020
	(0.0002)	(0.0003)	(0.0023)	(0.0003)	(0.0016)	(0.0018)	(0.0015)	(0.0002)	(0.0003)	(0.0021)
γ_{44}	0.0010	0.0002	0.0009	0.0009	0.0001	0.0003	0.0004	-0.0004	-0.0002	0.0002
	(0.0010)	(0.0008)	(0.0007)	(0.0006)	(0.0009)	(0.0006)	(0.0007)	(0.0007)	(0.0003)	(0.0006)
γ_{45}	0.0073**	0.0052	0.0061*	0.0044	0.0052	0.0064**	0.0022	0.0002	0.0027	0.0000
	(0.0028)	(0.0050)	(0.0035)	(0.0029)	(0.0044)	(0.0029)	(0.0025)	(0.0017)	(0.0019)	(0.0027)
α_5	0.9512***	0.7831***	1.0163***	1.2392***	1.1544***	0.6898***	0.6359***	1.0016***	1.0287***	0.5836***
	(0.1188)	(0.1319)	(0.1137)	(0.0880)	(0.1718)	(0.1087)	(0.1734)	(0.1532)	(0.2148)	(0.0486)
β_5	-0.0112***	-0.0372***	-0.0088***	0.0357***	-0.0015	-0.0457***	-0.0553***	0.0011	-0.0164	-0.0466***
	(0.0016)	(0.0128)	(0.0011)	(0.0136)	(0.0023)	(0.0079)	(0.0100)	(0.0052)	(0.0147)	(0.0100)
γ_{55}	-0.0070	0.0048	0.0008	0.0272	-0.0333	-0.0422	-0.0339	0.0161	-0.0613**	-0.0813***
	(0.0468)	(0.0276)	(0.0314)	(0.0373)	(0.0443)	(0.0288)	(0.0444)	(0.0446)	(0.0243)	(0.0202)
λ_1		-0.0021***		-0.0001	-0.0013**	-0.0032***	-0.0031***	-0.0016***	-0.0019***	-0.0021***
		(0.0006)		(0.0001)	(0.0005)	(0.0006)	(0.0005)	(0.0004)	(0.0005)	(0.0002)
λ_2	0.0011***	0.0008***	0.0009***	0.0010***	0.0010***	0.0006**	0.0007***	0.0011***	0.0008***	
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	
λ_4			-0.0002**		-0.0002**	-0.0002**	-0.0002***			-0.0001**
			(0.0001)		(0.0001)	(0.0001)	(0.0001)			(0.0001)
λ_5		0.0010**		-0.0017***		0.0019***	0.0025***		0.0010*	0.0025***
		(0.0005)		(0.0006)		(0.0003)	(0.0004)		(0.0005)	(0.0002)
Observations	7,954	8,131	7,829	7,881	7,626	7,419	7,263	7,085	7,049	6,360
Demographic Dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Regional Dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Source: Authors' estimations using data from ENIGH (2018).

Table 18: Computed Elasticities of QUAIDS

	Decile 1						**Decile 2**					
	Income	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**	**Income**	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**
Good 1	1.038	-2.544	0.413	-0.354	0.094	0.117	1.040	-2.739	1.223	0.182	-0.083	0.110
Good 2	0.664	0.823	-0.860	0.233	-0.077	-0.120	-0.383	0.946	-0.399	-0.115	0.043	-0.129
Good 3	-0.032	0.318	-0.207	-1.300	-0.005	0.039	1.185	0.430	-0.613	-1.054	0.027	0.027
Good 4	1.121	-0.069	0.006	0.021	-0.998	0.007	0.939	-0.072	0.002	0.006	-1.002	0.006
Good 5	0.999	0.434	-0.015	1.430	-0.136	-1.043	1.000	0.394	0.168	-0.204	0.075	-1.014

	Decile 3						**Decile 4**					
	Income	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**	**Income**	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**
Good 1	1.039	-2.950	1.876	0.582	0.348	0.086	1.029	-2.633	2.320	-0.283	-0.080	0.074
Good 2	-1.733	1.041	-0.217	0.050	-0.160	-0.109	-2.429	0.886	-0.316	-0.200	0.029	-0.087
Good 3	2.918	0.586	-0.574	-1.456	-0.191	0.015	-1.289	0.490	-1.533	-1.707	0.017	0.015
Good 4	1.369	-0.104	0.097	-0.157	-1.007	0.005	0.913	-0.049	-0.064	0.036	-1.001	0.001
Good 5	0.991	0.388	0.548	-1.940	-0.359	-0.987	1.038	0.277	2.016	3.441	0.121	-1.051

	Decile 5						**Decile 6**					
	Income	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**	**Income**	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**
Good 1	1.009	-2.882	1.226	0.337	0.243	0.112	1.008	-3.031	1.319	-0.035	0.121	0.080
Good 2	-1.878	0.921	-0.508	-0.016	-0.076	-0.086	-1.130	1.123	-0.647	-0.068	-0.055	-0.091
Good 3	1.559	0.482	-0.763	-1.089	-0.081	0.006	0.606	0.536	-0.868	-1.148	-0.014	0.024
Good 4	1.252	-0.065	0.101	-0.034	-1.007	0.002	1.152	-0.066	0.066	0.015	-1.002	0.003
Good 5	1.016	0.536	1.818	-0.757	-0.331	-1.051	1.025	0.431	1.258	0.630	-0.203	-1.044

	Decile 7						**Decile 8**					
	Income	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**	**Income**	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**
Good 1	0.996	-2.968	1.306	0.373	0.208	0.095	0.988	-3.254	1.329	0.459	0.140	0.083
Good 2	-2.652	0.976	-0.141	-0.071	-0.082	-0.088	-2.540	1.125	-0.449	0.030	-0.044	-0.085
Good 3	1.707	0.510	-0.484	-1.128	-0.080	0.001	2.203	0.650	-0.002	-1.368	-0.079	-0.013
Good 4	1.236	-0.052	0.150	-0.047	-1.009	0.000	1.177	-0.085	0.141	-0.086	-1.004	-0.001
Good 5	1.010	0.537	1.820	-0.833	-0.274	-1.018	1.009	0.576	1.519	-1.238	-0.189	-0.993

	Decile 9						**Decile 10**					
	Income	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**	**Income**	**Price 1**	**Price 2**	**Price 3**	**Price 4**	**Price 5**
Good 1	0.924	-4.467	0.773	0.411	-0.133	0.106	0.870	-3.434	0.100	0.124	0.057	0.067
Good 2	-3.178	1.750	-0.719	0.016	0.026	-0.064	0.887	1.458	-0.984	-0.072	-0.037	-0.053
Good 3	1.574	0.589	-0.645	-1.164	0.049	-0.002	1.236	0.048	-0.018	-1.053	-0.024	0.027
Good 4	0.871	-0.126	-0.101	0.005	-1.005	0.003	1.114	-0.122	0.004	-0.008	-1.003	0.000
Good 5	1.022	1.330	3.868	-0.843	0.192	-1.066	1.000	1.179	0.010	-0.228	-0.107	-1.041

Source: Authors' compilation using data from ENIGH (2018).