A general framework for measuring VAT compliance rates

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Summary measures of Value Added Tax (VAT) compliance rates are valuable for identifying problem areas in VAT implementation. They are also essential for meaningful cross-country and crosstime comparisons of VAT compliance. We present a comprehensive and general framework for calculating VAT compliance rates at both the economy-wide and detailed sectoral levels. Unlike existing measures of VAT compliance, our framework isolates a compliance measure from the effects on VAT receipts of detailed features of VAT systems as actually implemented by tax authorities. These features include multiple VAT rates, exemptions, registration rates, refund limitations, informal activity, taxation of domestic nonresidents and undeclared imports. We implement our comprehensive VAT compliance measure for Vietnam, a country with a complex VAT system. Our estimate of Vietnam’s VAT compliance rate is about 13 percentage points higher than that calculated by the most popular measure of compliance, Collection Efficiency (CE). Our method facilitates decomposition of the difference between CE and our VAT compliance measure into individual contributions by the statutory and structural features of Vietnam’s VAT regime.

Keywords: VAT; collection efficiency; revenue ratio; compliance rate

JEL Classification: H25; H26; C68

I. Introduction

The Value-Added Tax (VAT) has become the most common general consumption tax in the world.¹ The widespread use of the VAT is, in part, due to its perceived efficiency and effectiveness in raising tax revenue compared with other indirect taxes.² In the period 1998 to 2000, the average share of VAT revenue in total tax collected in countries with a VAT was over 20%.³ However, like other taxes, the VAT is vulnerable to tax evasion, tax fraud and poor enforcement. Given the VAT’s revenue-raising importance, there have been many time series and cross-country studies investigating the effectiveness of VAT compliance and enforcement. The most popular measure of such effectiveness is the Collection Efficiency (CE) index. CE is defined as the ratio of actual VAT revenue to potential VAT revenue with full compliance. Most studies calculate potential VAT revenue crudely, multiplying a single VAT

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¹ By mid-2006, there were around 140 countries with a Value-Added Tax (VAT) (Bird and Gendron, 2007).
² See, for example, Cnossen (1990) and OECD (2008).
³ Bird and Gendron (2007, p. 231).
rate by the value of final consumption. In doing this, most researchers acknowledge that this crude measure ignores the detailed features of VAT systems as actually implemented by tax authorities – namely, differential VAT rates, VAT exemptions, differential registration rates and VAT refund on investment good purchases. However, use of the CE index in policy debate is not always as careful in qualifying the effects of these omissions. Moreover, in calculating CE indices that do not take into account the details of real-world VAT systems, VAT researchers risk seeing their CE measures misinterpreted and policy makers misinformed. In this article, we propose a new framework to calculate a VAT compliance and enforcement index that takes account the aforementioned features of real-world VAT systems.

This article is structured as follows. In Section II, we review existing measures of VAT compliance and the use of these measures in VAT research. Section III presents a comprehensive framework for modelling and calculating VAT Compliance Rates (CRs). In Section IV, we apply the framework to a complex real-world VAT system, that of Vietnam. Using the new framework, in Section V we calculate a measure of Vietnam’s CR and explore the specific influences on this measure of Vietnam’s VAT system and economic structure. Section VI concludes this article.

II. Existing Measures of VAT Compliance

Two measures of VAT revenue collection efficacy most commonly used by analysts undertaking cross-country and cross-time studies are VAT Productivity (VP) and VAT Collection Efficiency (VAT CE). VP is the ratio of VAT revenue to the product of the standard VAT rate and Gross Domestic Product (GDP). VAT CE is the ratio of VAT revenue to the product of the standard VAT rate and final consumption. These measures have been used in many studies to investigate compliance and enforcement issues. They have been used as instruments for: (i) understanding the cross-country determinants of VAT compliance (Gebauer et al., 2007; Aizenman and Jinjarak, 2008; de Mello, 2009); (ii) comparing VAT compliance across countries (Jack, 1996; Bird and Gendron, 2007; OECD, 2008); (iii) comparing country-specific VAT compliance over time (Jack, 1996; Gebauer et al., 2007; Hybka, 2009); (iv) determining the optimum VAT rate (Matthews, 2003); and (v) evaluating the effect of VAT reform models on VAT evasion (Gebauer et al., 2007).

In using the VP and CE measures to investigate VAT characteristics and compliance, deviations from one in these measures are often interpreted as a measure of noncompliance due to tax evasion, tax fraud and administrative inefficiency or laxity. At the same time, most authors acknowledge that the deviations are likely to be, in part, due to limitations in the indices themselves, rather than variations in the particular VAT feature for which the index is being used as an instrument.

The VAT compliance literature identifies a number of limitations to the VP and CE measures. One limitation, easily corrected, is that the VP and CE indices do not exclude the VAT itself from their final consumption base. The Organization for Economic Cooperation and Development (OECD; 2008, pp. 66–70) defines a modified version of the CE, which it calls the VAT Revenue Ratio (VRR). VRR is calculated using the pre-VAT value of the consumption base. An obvious shortcoming of all three measures (CE, VP and VRR) is that in calculating potential revenue, they use only one standard VAT rate. This is despite many countries having multiple rates, and with these rates often varying considerably.

Perhaps the most important limitation of the CE, VP and VRR measures is that the VAT bases used by each can be very different from real-world VAT bases. For example, Aizenman and Jinjarak (2008) recognize that the CE and VP indexes do not distinguish between the effects of tax evasion and the effects of statutory exemptions. Similarly, de Mello (2009), Bird and Gendron (2007, pp. 62–65),

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4 Aizenman and Jinjarak (2008) use the ratios as instruments for understanding how political and structural factors affect compliance and enforcement rates across countries. They found that the CE index is positively correlated to the urbanized share of the population, real GDP per capita, trade openness, political stability and political participation. It is negatively correlated to GDP share of agriculture. de Mello (2009) uses the CE index as a measure of tax compliance in a model of a tax avoidance game between taxpayers and the tax authority. Matthews (2003) uses a ratio similar to the VP as a measure of compliance in his estimate of the revenue maximizing rate of VAT in the European Union. Gebauer et al. (2007) evaluate the effect of VAT reform models on VAT evasion in the EU in general and in Germany in particular. Hybka (2009) estimates and explains CE in Poland over time.

5 See, for example, Aizenman and Jinjarak (2008), de Mello (2009) and Gebauer et al. (2007).

6 Among 142 countries listed as having a VAT in Bird and Gendron (2007, pp. 223–226), 76 countries have 1 rate, 32 countries have 2 rates and 25 countries have 3 rates. The remaining countries have even more rates. An extreme example is Brazil, where the standard rate is 20.5%, but there exist more than 20 VAT rates ranging from 1% to 350%.

7 GDP for the VP index, post-VAT final consumption for the CE index and pre-VAT final consumption for the VRR index.
Matthews (2003) and Jack (1996) acknowledge that factors other than tax evasion influence the CE index. These factors include differential VAT rates, differential exemptions, economic activity in the informal sector and the proportion of imports in total consumption. As a result, the VP, CE and VRR indexes tend to overestimate the extent of noncompliance. Keen and Smith (2006) note that as such, results from econometric studies that use these measures should be interpreted with caution.

A more recent class of VAT compliance measure goes some way towards addressing the limitations of the VP, CE and VRR measures. These measures are variously known as the Compliance Index (CI) (Agha and Haughton, 1996), VAT gap (Swedish National Tax Agency, 2008; HM Revenue & Customs, 2010) or VAT evasion rate (Gebauer and Parsche, 2003). Hereafter, we refer to this class of measure as the CI. The CI compares actual VAT revenues with an estimate of the expected VAT revenue that would be collected in the presence of full compliance. As described in a review by Keen and Smith (2006), the few studies which use the CI calculate expected VAT revenue in a ‘top down’ manner via a number of steps. First, potential VAT revenue is calculated by multiplying the value of final consumption, classified according to the pattern of VAT rates, with their associated VAT rates. Next, adjustment is made to the initial revenue estimate to account for input-taxed exemptions, and for VAT paid by businesses that are legitimately not registered for VAT. Hence, the CI improves on the CE measure by acknowledging differential VAT rates and bases.

Nevertheless, existing CI measures also have limitations. As acknowledged by users of the CI, the macro national accounts data upon which they are calculated may not be sufficiently disaggregated to cleanly map with the multiplicity of differential VAT rates and exemptions. In addition, important features of actual VAT systems remain absent. These features include informal sector activity, and the effect of legal exemption rates and industry VAT registration rates on commodity-specific VAT rates and industry refund rates. Finally, researchers calculating CI-like measures have not, to date, set out a formal framework for calculating the measure that can be readily applied across countries.

The method we propose in this article is in the CI tradition. However, it goes much further, using detailed national accounts supply–use data, together with tax and exemption matrices constructed from the tax code, to develop a more precise estimate of VAT compliance.

### III. A General Framework for Measuring VAT CRs

We set out a formal and comprehensive framework for calculating average and base-specific CRs. The framework models all statutory and structural elements which affect VAT legal rates and the effective bases on which the VAT is levied. By offering a comprehensive calculation of potential VAT revenue, our measure offers the prospect that the bulk of the difference between potential revenue and actual revenue is due to factors relating to VAT compliance and enforcement, such as administrative inefficiency, tax evasion, tax avoidance and lax enforcement. Hereafter, we refer to our measure as the CR.

VAT is often understood as a tax on final consumption, because VAT paid on inputs to production is refunded. However, in practice, the base of the VAT is much broader than final consumption, encompassing elements of production, investment and export. The size of the base on which VAT is ultimately levied depends on a number of factors, including legal exemptions, VAT registration rates, the size of the informal sector and limitations on VAT credit. Linkages between commodity-specific exemptions and the capacity of industry to reclaim VAT on their inputs are not straightforward if industries exhibit multi-production, and if exemptions on a given commodity differ across users of that commodity. Yet, these features of real-world VAT systems are critical to correctly calculate the VAT revenue that a given jurisdiction can reasonably expect to collect from its VAT system as implemented. Giesecke and Tran (2010) outline a formal

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8 For the UK, for example, the VP and the CE were 0.38 and 0.56, respectively, for the period 1998 to 2000 (Bird and Gendron, 2007, p. 231). However, estimates by HM Revenue & Customs of the ‘VAT gap’ for this period were around 15% (Keen and Smith, 2006).

9 See, for example, Agha and Haughton (1996), HM Revenue & Customs (2010) and Swedish National Tax Agency (2008). Agha and Haughton (1996) acknowledge that they have made simplifying assumptions about the breakdown of consumption expenditure across goods and services. They also assume that the inputs used to produce exempt goods were taxed at the standard VAT rate. HM Revenue & Customs (2010) and Swedish National Tax Agency (2008) acknowledge that their estimates of the VAT gap are subject to a degree of uncertainty due to both errors contained in the input data itself and the top-down nature of their estimates.

10 For a detailed discussion on features of VAT systems, see, for example, Ebrill et al. (2001).
description of a VAT system that models multi-production, multiple VAT rates and multiple VAT exemptions. We extend that system in this article, adding differential VAT registration rates, undeclared imports, unclaimed VAT on tourists’ purchases and general and transaction-specific CRs.

We assume an economy of $M$ commodities, from $S$ sources, used by $U$ agents. The $U$ agents are comprised of $N$ industries, $K$ capital creators and $F$ final demanders. The economy and its VAT regime have the following features.

**Multi-production**

We represent this via $SO_{c,j}$, the share of total output of industry $j$ represented by output of commodity $c$; and $SJ_{c,j}$, the share of total output of commodity $c$ represented by output of $c$ by industry $j$. $SO_{c,j}$ and $SJ_{c,j}$ can be evaluated from the multi-production matrix of a country’s input–output or supply–use tables. In the Vietnam implementation of our system, described in Section IV, $M = 113$ and $N = 113$.

**Differentiated legislated VAT rates**

We represent differences in legislated VAT rates across commodities, sources and domestic users via $LR_{c,s,u}$, a matrix of legislated VAT rates on sales of commodity $c$ from source $s$ to user $u$. In our Vietnam implementation, $U = 229$, comprised of 113 industries ($N = 113$), 113 investors ($K = 113$) and 3 final users: households, government and exports ($F = 3$). We evaluate the $113 \times 2 \times 29$ $LR_{c,s,u}$ matrix through careful inspection of the Vietnamese tax code (National Assembly, 2003). Typical values for $LR_{c,s,u}$ are 0, 0.05 and 0.10.

**Differentiated VAT legal exemptions for commodities**

We model exemptions via $LEX_{c,s,u}$, a coefficient measuring the share of sales of commodity $c$ from source $s$ to user $u$ that are VAT exempt by law. For most flows, $LEX_{c,s,u}$ is zero. $LEX_{c,s,u}$ has a nonzero value where the tax code exempts from VAT some or all the sales of commodity $c$ to user $u$. For full exemption, $LEX_{c,s,u} = 1$. For partial exemption, $0 < LEX_{c,s,u} < 1$. The latter reflects data aggregation. For example, many countries exempt textbooks. But in most input–output databases, textbooks form part of a broad commodity like ‘publishing’. We assume that if textbooks are 40% of ‘publishing’ sales to user $u$, then $LEX_{\text{publishing}, u} = 0.4$.

**Differentiated degree of VAT registration**

We represent the VAT registration rate of producers via $REG_{j}$, the proportion of industry $j$’s output that is produced by VAT-registered firms. Businesses may not register for VAT for two reasons. First, VAT codes in many countries allow businesses with revenue or income under a certain threshold to not register for VAT. This is in recognition that VAT compliance costs can be disproportionately high for small businesses, relative to the value of VAT foregone by nonregistration. We represent the proportion of industry $j$’s output produced by legally nonregistered businesses via $NRI_{j}$. Second, many businesses, especially small ones, may choose to operate informally. That is, they may not register as a business in order to avoid paying taxes or social security insurance, or to avoid complying with government regulations on labour standards and business reporting. We represent the proportion of industry $j$’s output produced by informal businesses via $NRI_{j}$.

**The presence of informal imports**

By informal imports, we mean imports which are not declared for customs purposes. We assume that informal imports are not subject to VAT. We denote the proportion of imports of commodity $c$ that are informal by $IM_{c}$.

**Differentiated legal refundability on VAT paid on inputs to capital formation**

We use the parameter $\psi_{c,s,j}$ to denote the proportion of VAT paid by industry $j$ ($j \in K$) on purchases of $c$ from source $s$ for capital formation that is refunded under the jurisdiction’s VAT legislation. Most VAT

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11 Note that $K = N$. That is, investors are also producers.
12 While the Vietnamese $SO_{c,j}$ and $SJ_{c,j}$ matrices are square, they are not diagonal. On the contrary, the Vietnamese economy is characterized by a high level of multi-production.
13 In this example, we also assume that textbooks are the only VAT-exempt component of publishing.
14 The 1993 SNA (United Nations (UN), 2001) defines the informal sector as the set of small-scale unincorporated enterprises owned by households which produce at least some products for the market but which either have less than a specified number of employees and/or are not registered under national legislation referring, for example, to tax or social security obligations, or regulatory acts. The informal (or ‘invisible’) economy, can be sizable in many countries. Schneider (2005) estimates that the informal economy may represent up to 41% of GDP in developing countries, and 17% in OECD countries.
systems provide for full refund of VAT paid on inputs to capital formation. Hence, for most \( c, s, j, \psi_{c,s,j} = 1 \). However, an important exception is construction of dwellings. Consistent with long-run input-taxation of dwellings services, most VAT systems provide no refund of VAT paid on inputs to housing construction. This is also true of the Vietnamese VAT system. The Vietnamese system also disallows VAT refunds on specialized equipment used in capital formation by national defence, health and education.

**Effective taxation of exports via application of VAT on domestic purchases by nonresidents**

Under most VAT systems, exports are explicitly zero rated. Nevertheless, domestic nonresidents, particularly tourists, pay VAT on their purchases. Recognizing that this represents an application of VAT to exports, many countries provide for some refund of this VAT at the time of the nonresident’s departure. Such VAT refund schemes typically only cover a part of the purchases made by domestic nonresidents, and even then, many nonresidents may fail to claim their full VAT refund entitlement.

**The presence of inefficiency in VAT collection**

VAT collection inefficiency can arise from tax evasion on the part of registered businesses and tax enforcement by tax authorities. The many ways that VAT can be avoided are well-documented (see, e.g., Agha and Haughton, 1996; Ebrill et al., 2001; Keen and Smith, 2006). We denote the degree of compliance on the part of registered businesses and lax enforcement by tax authorities. The many ways that VAT collection inefficiency can arise from tax evasion is represented in Equation E3 by \( \phi^3_c \), which measures the proportion of VAT paid on domestic purchases by nonresidents that is reclaimable under the country’s VAT refund scheme. The remainder of Equation E3 models VAT on foreign sales. These sales attract VAT at the legislated rate for households. Under some VAT regimes, nonresidents, at the time of their departure, may claim refund of some VAT paid on their domestic purchases. This is represented in Equation E3 by \( \psi^3_{s,u} \), which measures the proportion of VAT paid on domestic purchases by nonresidents that is reclaimable under the country’s VAT refund scheme. The remainder of Equation E3 models VAT on foreign sales. These sales attract VAT at the legislated rate for exports, which will generally be zero under most VAT systems.

Equation E4 calculates aggregate actual VAT revenue (AVATTOT) as the sum of actual VAT revenue collected on each commodity-, source- and agent-specific transaction (AVAT\(_{c,s,u}\)).

Equation E5 calculates aggregate expected VAT revenue (EVATTOT) as the sum of expected VAT revenue on each commodity-, source- and agent-specific transaction (EVAT\(_{c,s,u}\)).

Equation E6 defines the average economy-wide VAT CR as the ratio of aggregate actual VAT revenue (AVATTOT) to aggregate expected VAT revenue (EVATTOT).

Equation E7 calculates the value of the transaction base on which VAT may potentially be levied (TRBASE\(_{c,s,u}\)). Depending on the specifics of each country’s VAT legislation, this base can be the basic

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16 See, for example, the UK VAT regulation on this issue (HM Revenue & Customs, 2004). Typically, travellers can claim VAT on purchases which exceed a certain value and are taken out of the country. But they cannot claim VAT on goods or services which are consumed inside the country, such as meals, travel and hotel expenses.
I. The core VAT model

(E1) \[ \text{AVAT}_{s,u} = \text{CRT}_{s,u} \times \text{EVAT}_{s,u} \] \hspace{1cm} (c \in M, s \in S, u \in U)

(E2) \[ \text{EVAT}_{s,v} = \text{VATBASE}_{s,v} \times \text{LR}_{s,v} \] \hspace{1cm} (c \in M, s \in S, v \in V)

(E3) \[ \text{EVAT}_{s,\text{export}} = \] \hspace{1cm} (c \in M, s \in S)
\[ \left[ \text{TRBASE}_{s,\text{export}} \times (1 - \text{EX}_{s,\text{household}}) \right] \times \text{SHNRES}_{s} \times (1 - \phi^{(3)}_{s}) \times \text{LR}_{s,\text{export}} + \] \[ \left[ \text{TRBASE}_{s,\text{export}} \times (1 - \text{EX}_{s,\text{export}}) \right] \times (1 - \text{SHNRES}_{s}) \times \text{LR}_{s,\text{export}} \]

(E4) \[ \text{AVATTOT} = \sum_{c \in M} \sum_{s \in S} \sum_{u \in U} \text{AVAT}_{s,u} \]

(E5) \[ \text{EVATTOT} = \sum_{c \in M} \sum_{s \in S} \sum_{v \in V} \text{EVAT}_{s,v} \]

(E6) \[ \text{CR} = \text{AVATTOT} / \text{EVATTOT} \]

(E7) \[ \text{TRBASE}_{s,u} = \text{BASIC}_{s,u} \times (1 + T_{s,u}) \times (1 - M_{s,u}) \] \hspace{1cm} (c \in M, s \in S, u \in U)

(E8) \[ \text{VATBASE}_{s,f} = \text{TRBASE}_{s,f} \times [1 - \text{EX}_{s,f}] \] \hspace{1cm} (c \in M, s \in S, f \in D)

(E9) \[ \text{VATBASE}_{s,j} = \text{TRBASE}_{s,j} \times [1 - \text{EX}_{s,j}] \times [1 - \phi^{(1)}_{s,j}] \] \hspace{1cm} (c \in M, s \in S, j \in N)

(E10) \[ \text{VATBASE}_{s,k} = \text{TRBASE}_{s,k} \times [1 - \text{EX}_{s,k}] \times [1 - \phi^{(2)}_{s,k}] \] \hspace{1cm} (c \in M, s \in S, k \in K)

(E11) \[ \phi^{(1)}_{j} = \text{REG}_{j} \times \sum_{c \in M} \sum_{s \in S} \sum_{u \in U} \text{SS}_{s,u} \times [1 - \text{LEX}_{c,\text{import}}] \] \hspace{1cm} (j \in N)

(E12) \[ \text{REG}_{j} = (1 - \text{NRI}_{j}) \times (1 - \text{NRL}_{j}) \] \hspace{1cm} (j \in N)

(E13) \[ \text{EX}_{s,u} = \max \{ \text{LEX}_{s,u}, \text{DEX}_{s,u} \} \] \hspace{1cm} (c \in M, s \in S, u \in U)

(E14) \[ \text{DEX}_{c,\text{Domestic}} = 1 - \sum_{j \in N} \text{SI}_{s,j} \times \text{REG}_{j} \] \hspace{1cm} (c \in M)

(E15) \[ \text{DEX}_{c,\text{Import}} = \text{IM}_{c} \] \hspace{1cm} (c \in M)

(E16) \[ \phi^{(2)}_{s,k} = \phi^{(2)}_{s,k} \times \text{REG}_{k} \] \hspace{1cm} (c \in M, s \in S, k \in K)

(E17) \[ \text{CRT}_{s,u} = \text{FCRT}_{s,u} \times \text{FCR} \] \hspace{1cm} (c \in M, s \in S, u \in U)

Fig. 1. Equations of the VAT model
II. Equations for summary variables reported in Table 1

(E18) \[
\text{AVELR}_{\text{producers}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w \in S} \sum_{j \in J} \left( \text{VATBASE}_{c,j} \times LR_{c,j} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w \in S} \sum_{j \in J} \text{VATBASE}_{c,j}}
\]

(E19) \[
\text{AVELR}_{\text{investors}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w \in S} \sum_{k \in K} \left( \text{VATBASE}_{c,k} \times LR_{c,k} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w \in S} \sum_{k \in K} \text{VATBASE}_{c,k}}
\]

(E20) \[
\text{AVELR}_f = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{VATBASE}_{c,j} \times LR_{c,f} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{VATBASE}_{c,j}} \quad (f \in D)
\]

(E21) \[
\text{AVELEX}_{\text{producers}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{TRBASE}_{c,j} \times LEX_{c,j} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{TRBASE}_{c,j}}
\]

(E22) \[
\text{AVELEX}_{\text{investors}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{k \in K} \left( \text{TRBASE}_{c,k} \times LEX_{c,k} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{k \in K} \text{TRBASE}_{c,k}}
\]

(E23) \[
\text{AVELEX}_f = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{TRBASE}_{c,j} \times LEX_{c,f} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{TRBASE}_{c,j}} \quad (f \in D)
\]

(E24) \[
\text{AVEDEX}_{\text{producers}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{TRBASE}_{c,j} \times DEX_{c,j} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{TRBASE}_{c,j}}
\]

(E25) \[
\text{AVEDEX}_{\text{investors}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{k \in K} \left( \text{TRBASE}_{c,k} \times DEX_{c,k} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{k \in K} \text{TRBASE}_{c,k}}
\]

(E26) \[
\text{AVEDEX}_f = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{TRBASE}_{c,j} \times DEX_{c,f} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{TRBASE}_{c,j}} \quad (f \in D)
\]

(E27) \[
\text{AVEEX}_{\text{producers}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{TRBASE}_{c,j} \times EX_{c,j} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{TRBASE}_{c,j}}
\]

(E28) \[
\text{AVEEX}_{\text{investors}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{k \in K} \left( \text{TRBASE}_{c,k} \times EX_{c,k} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{k \in K} \text{TRBASE}_{c,k}}
\]

(E29) \[
\text{AVEEX}_f = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{TRBASE}_{c,j} \times EX_{c,f} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{TRBASE}_{c,j}} \quad (f \in D)
\]

(E30) \[
\text{AVEREF}_{\text{producer}} = \frac{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \left( \text{TRBASE}_{c,j} \times \phi_{j}^{(i)} \right)}{\sum_{c \in C} \sum_{m \in M} \sum_{w} \sum_{j \in J} \text{TRBASE}_{c,j}}
\]

Fig. 1. Continued
(E31) \[ \text{AVEREF}_{\text{investor}} = \sum_{cc} \sum_{sc} \sum_{kc} \sum_{r} \frac{\text{TRBASE}_{r,k} \times \phi^{(2)}_{r,k}}{\sum_{cc} \sum_{sc} \sum_{kc} \text{TRBASE}} \]

(E32) \[ \text{VATBASETOT}_{\text{producers}} = \sum_{cc} \sum_{sc} \sum_{j} \text{VATBASE}_{c,s,j} \]

(E33) \[ \text{VATBASETOT}_{\text{investors}} = \sum_{cc} \sum_{sc} \sum_{kc} \text{VATBASE}_{c,s,k} \]

(E34) \[ \text{VATBASETOT}_{f} = \sum_{cc} \sum_{sc} \sum_{f} \text{VATBASE}_{c,s,f} \quad (f \in D) \]

(E35) \[ \text{EVATTOT}_{\text{producers}} = \sum_{cc} \sum_{sc} \sum_{j} \text{EVAT}_{c,s,j} \]

(E36) \[ \text{EVATTOT}_{\text{investors}} = \sum_{cc} \sum_{sc} \sum_{kc} \text{EVAT}_{c,s,k} \]

(E37) \[ \text{EVATTOT}_{f} = \sum_{cc} \sum_{sc} \sum_{f} \text{EVAT}_{c,s,f} \quad (f \in D) \]

(E38) \[ \text{EVATEXP} = \sum_{cc} \sum_{sc} \text{EVAT}_{c,s,\text{export}} \]

III. Equations for summary variables reported in Table 3

(E39) \[ \text{AVELRTOT} = \sum_{cc} \sum_{sc} \sum_{uc} \left( \text{VATBASE}_{c,s,u} \times \text{LR}_{c,s,u} \right) / \sum_{cc} \sum_{sc} \sum_{uc} \text{VATBASE}_{c,s,u} \]

(E40) \[ \text{AVELEXTOT} = \sum_{cc} \sum_{sc} \sum_{uc} \left( \text{TRBASE}_{c,s,u} \times \text{LEX}_{c,s,u} \right) / \sum_{cc} \sum_{sc} \sum_{uc} \text{TRBASE}_{c,s,u} \]

(E41) \[ \text{AVEDEXTOT} = \sum_{cc} \sum_{sc} \sum_{uc} \left( \text{TRBASE}_{c,s,u} \times \text{DEX}_{c,s,u} \right) / \sum_{cc} \sum_{sc} \sum_{uc} \text{TRBASE}_{c,s,u} \]

(E42) \[ \text{AVEEEXTOT} = \sum_{cc} \sum_{sc} \sum_{uc} \left( \text{TRBASE}_{c,s,u} \times \text{EX}_{c,s,u} \right) / \sum_{cc} \sum_{sc} \sum_{uc} \text{TRBASE}_{c,s,u} \]

Fig. 1. Continued
value of the transaction only (BASIC\text{c,s,u}), or it may also include certain taxes (T\text{c,s,u}) and margins (M\text{c,s,u}) accruing on the transaction.\footnote{For most countries, the VAT transaction base is the basic value of the relevant transaction, plus all relevant trade, transport, insurance and other margins. For Vietnam, the value of the transaction base also includes an indirect tax known as special consumption tax.} Equation E7 allows for both possibilities.

Equations E8–E10 define VAT bases (VATBASE\text{c,s,u}). By VAT base, we mean the value of transactions subject to VAT after taking into account all legal exemptions, legal registration rates, informal activity and the production and sales structure of economic activity. The VAT base for purchases of inputs to current production, capital formation and final demand are defined by Equations E8, E9 and E10, respectively. In each case, the VAT base is the product of the value of the transaction base potentially subject to VAT and a set of coefficients describing exemption rates (EX\text{c,s,u}) and refund factors (\phi^{(1)}\text{c,s,k}, \phi^{(2)}\text{c,s,k}). The latter coefficients are defined by Equations E11–E16.

Equation E11 defines \phi^{(1)}\text{c,s}, the VAT refund factor on purchases of intermediate inputs into current production. When producer j buys input c from source s, it must pay a VAT rate equivalent to the legislated rate less the exemption proportion applicable to (c, s) and j. Industry j then reclaims this tax, but only to the extent input (c, s) is used to produce nonexempt goods, and even then, only to the extent that firms in industry j are registered for VAT. Industry j’s capacity to reclaim VAT paid on inputs is modelled by the refund factor, \phi^{(1)}\text{j}, defined by Equation E11 as the proportion of industry j’s VAT payments on inputs to production that is refunded by the tax authority. In Equation E11, we first see the VAT registration rate, REG\text{j}, in recognition that only registered firms can reclaim VAT paid on their inputs. The remainder of Equation E11 recognizes that to calculate \phi^{(1)}\text{j} we must look to three dimensions of industry j’s sales: what it produces, to whom it sells and whether its sales are VAT exempt. Data on the first dimension are provided by SO\text{c,j}, already discussed above. For the second dimension, we introduce SS\text{c,u}, the share of total sales of commodity c sold to user u. We can evaluate SS\text{c,u}.
(a) Variables and parameter in the core model (Equations E1–E17), in alphabetical order

| Variable | Range | Description | Closure |
|----------|-------|-------------|---------|
| 1 AVAT	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | Actual VAT collections from the sale of commodity \(c\) from source \(s\) to user \(u\). | En. |
| 2 AVATTOT |  | Actual VAT collections, net of all refunds. | Ex.\textsuperscript{a} |
| 3 BASIC	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | Value, at basic prices, of purchases by user \(u\) of commodity \(c\) from \(s\). | Ex.\textsuperscript{b} |
| 4 CR |  | Average economy-wide VAT compliance rate. | En. |
| 5 CRT	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | Transaction-specific compliance rates. | En. |
| 6 DEX	extsubscript{c,domestic} | \((c \in M)\) | De-facto exemption: the proportion of sales of domestically-produced commodity \(c\) that are effectively VAT exempt due to non-registration by producers of \(c\). | En. |
| 7 DEX	extsubscript{c,import} | \((c \in M)\) | De-facto exemption: the proportion of sales of imported commodity \(c\) that are effectively VAT exempt due to undeclared imports. | En. |
| 8 EX	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | The proportion of sales of commodity \(c\) from source \(s\) to user \(u\) that are effectively VAT exempt. | En. |
| 9 EVAT	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | Expected VAT revenues. | En. |
| 10 EVATTOT |  | Total expected VAT revenue. | En. |
| 11 FCR |  | Uniform shift variable on transaction-specific compliance rates. | En. |
| 12 FCRT	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | Shifter on transaction-specific compliance rates. | Ex.\textsuperscript{c} |
| 13 IM	extsubscript{c} | \((c \in M)\) | The proportion of imports that are not declared for tax purposes. | Ex.\textsuperscript{d} |
| 14 LEX	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | The proportion of sales of commodity \(c\) from source \(s\) to user \(u\) that are legally VAT exempt. | Ex.\textsuperscript{e} |
| 15 LR	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | The legal VAT rate on purchases of commodity \(c\), from source \(s\) by user \(u\). | Ex.\textsuperscript{f} |
| 16 M	extsubscript{c,s,u} | \((c \in M)\) \((s \in S)\) \((u \in U)\) | The value of margin services on flows of commodity \((c,s)\) to user \(u\), expressed as a proportion of the basic value of flows of \((c,s)\) to user \(u\). | Ex.\textsuperscript{g} |
| 17 NRI	extsubscript{j} | \((j \in N)\) | The proportion of industry \(j\)'s activity generated by firms which operate informally and are thus not registered for VAT. | Ex.\textsuperscript{h} |
| 18 NRL	extsubscript{j} | \((j \in N)\) | The proportion of industry \(j\)'s output produced by firms that are legally permitted not to register for VAT. | Ex.\textsuperscript{i} |
| 19 \(\phi_{j}^{(i)}\) | \((j \in N)\) | The proportion of VAT paid on inputs to | En. |
A general framework for measuring VAT compliance rates

|   |   |   |   |
|---|---|---|---|
| 20 | $\theta_{c,s,k}^{(2)}$ | $(c \in M)$ | The proportion of VAT paid on inputs of $(c,s)$ to capital formation by industry $k$ that is refunded by the tax authority. | En. |
| 21 | $\gamma_{c,s}^{(3)}$ | $(c \in M)$ | Proportion of VAT paid by non residents on purchases of commodity $c$ that is refundable under the VAT code. | Ex. |
| 22 | $\psi_{c,s,k}$ | $(c \in M)$ | The legal refund rate for VAT paid on inputs of $(c,s)$ to capital formation by industry $k$. | Ex. |
| 23 | REG$_j$ | $(j \in N)$ | The proportion of industry $j$’s production represented by firms registered for VAT. | En. |
| 24 | SHNRES$_{c,s}$ | $(c \in M)$ | Share of export sales of commodity $(c,s)$ representing domestic sales to non-resident agents (such as tourists). | Ex. |
| 25 | SJ$_{c,j}$ | $(c \in M)$ | Industry $j$’s share of total output of commodity $c$. | Ex. |
| 26 | SO$_{c,j}$ | $(c \in M)$ | The share of total output of industry $j$ represented by commodity $c$. | Ex. |
| 27 | SS$_{c,u}$ | $(c \in M)$ | The share of total sales of commodity $c$ sold to user $u$. | Ex. |
| 28 | T$_{c,u}$ | $(c \in M)$ | The rate of any indirect taxes that form part of the VAT tax base under the relevant jurisdiction’s tax code. | Ex. |
| 29 | TRBASE$_{c,s,u}$ | $(c \in M)$ | Valuation of the transactions on which VAT is potentially levied. | En. |
| 30 | VATBASE$_{c,s,u}$ | $(c \in M)$ | VAT base for purchases of commodity $c$, from source $s$ by user $u$. | En. |

(b) Variables reported in Table 1 (Equations E18–E38), by column

|   |   |   |   |
|---|---|---|---|
| 31 | AVELR$_{q}$ | $(q \in Q)$ | Weighted average legal rate faced by the broad classes of economic agent in the set $Q$, namely: producers, investors, households and government. | En. |
| 32 | AVELEX$_{q}$ | $(q \in Q)$ | Weighted average legal exemption rates on purchases by broad economic agents in the set $Q$. | En. |
| 33 | AVEDEX$_{q}$ | $(q \in Q)$ | Weighted average de facto exemption rates due to non-registration on all purchases by broad economic agents defined by set $Q$. | En. |
| 34 | AVEEX$_{q}$ | $(q \in Q)$ | Weighted average effective exemption rates on all purchases by broad economic agents in set $Q$. | En. |
| 35 | AVEREF$_i$ | $(i \in I)$ | Weighted average refund rate on all purchases by producers, and all inputs to | En. |

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For many jurisdictions, T$_{c,u}$ will be zero. However for Vietnam, the Special Consumption Tax, an indirect tax levied on consumption of certain goods deemed to be luxuries, forms part of the base subject to VAT under Vietnam’s VAT law (National Assembly, 2003).

Fig. 2. Continued
from row shares in an input–output database. For the third dimension, we represent the extent of non-exempt sales by \( [1 - \text{LEX}_{c, \text{dom}, a}] \). Equation E12 defines VAT registration rates, \( \text{REG}_j \). Equation E12 recognizes two influences on industry-specific VAT registration rates. The first is the size of the informal sector, represented in E12 by \( \text{NRI}_j \), which measures the proportion of industry \( j \)'s activity generated by firms in the informal sector. The second is legal nonregistration, represented in E12 by \( \text{NRL}_j \), the proportion of industry \( j \)'s output produced by firms that are legally permitted not to register for VAT.

|   | Column 1                                                                 | Column 2                                                                 |
|---|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 36 | VATBASETOT\(_q\) \((q \in Q)\) Aggregate VAT bases for purchases by broad economic agents in set \( Q \). | En.                                                                     |
| 37 | TRBASETOT\(_q\) \((q \in Q)\) Value of transaction bases on purchases by broad economic agents in set \( Q \). | En.                                                                     |
| 38 | EVATTOT\(_q\) \((q \in Q)\) Expected VAT liabilities on purchases by the broad set of agents defined by set \( Q \). | En.                                                                     |
| 39 | EVATEXP Total expected VAT revenues on export sales.                      | En.                                                                     |

(c) Variables reported in Table 3 (Equations 39–47), by row

|   | Column 1                                                                 | Column 2                                                                 |
|---|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 40 | AVELRTOT Economy-wide average legal rates, weighted by VAT base.         | En.                                                                     |
| 41 | AVELEXTOT Economy-wide average legal exemption rates, weighted by the VAT transaction base. | En.                                                                     |
| 42 | AVEDEXTOT Economy-wide average de facto exemption rates, weighted by the VAT transaction base. | En.                                                                     |
| 43 | AVEEEXTOT Economy-wide average effective exemption rates, weighted by the VAT transaction base. | En.                                                                     |
| 44 | AVEREFTOT Economy-wide average effective exemption rates, weighted by the VAT transaction base. | En.                                                                     |
| 45 | VATBASETOT Aggregate economy-wide VAT base.                              | En.                                                                     |

Ex. denotes exogenous  
En. denotes endogenous

\( a \) Data from the tax authority on actual VAT collections.  
\( b \) Calculated from the basic price use table of the national input-output statistics.  
\( c \) Exogenous set at 1, when independent values for \( \text{VAT}_{c, \text{dom}, a} \) are unavailable.  
\( d \) Calculated from information on total imports and undeclared imports.  
\( e \) Calculated from inspection of the VAT legislation of the relevant country.  
\( f \) Calculated from inspection of the VAT legislation of the relevant country.  
\( g \) Calculated from margin values in the national input-output table.  
\( h \) Based on survey or other independent estimates of the number and size of enterprises in each industry that operate informally.  
\( i \) Based on survey or other independent estimates of the number and size of enterprises in each industry that are legally permitted to not register for VAT, and have chosen to do so.  
\( j \) Calculated from inspection of the VAT legislation of the relevant country and the structure of tourist spending from other relevant statistics such as tourism satellite accounts.  
\( k \) Calculated from inspection of the VAT legislation of the relevant country.  
\( l \) Calculated from national input-output table, and other relevant statistics such as tourism satellite accounts.  
\( m \) Calculated from the supply table of the country’s input-output statistics.  
\( n \) Calculated from the supply table of the country’s input-output statistics.  
\( o \) Calculated from the basic price use table of the national input-output statistics.  
\( p \) Calculated from inspection of the national VAT legislation and the indirect tax matrices of the national input-output statistics.

Fig. 2. Continued
The nontaxed proportion of commodity \( c \) from source \( s \) to user \( u \), which we denote by the exemption factor \( \text{EX}_{c,s,u} \), is defined by \( \text{E13} \) as the maximum value of two measures: the legal exemption rate \( \text{LEX}_{c,s,u} \), and the de facto exemption rate due to nonregistration or illegal imports, \( \text{DEX}_{c,s} \). For example, Vietnam’s VAT law stipulates that exports of mining are VAT exempt; hence, \( \text{LEX}_{\text{mining,domestic.export}} = 1 \). Thus, via \( \text{E13} \), \( \text{EX}_{\text{mining,domestic.export}} = 1 \), regardless of how many mining producers register for VAT (i.e. regardless of the value for \( \text{DEX}_{\text{mining,domestic}} \)).

Equation \( \text{E14} \) models de facto exemption arising from nonregistration. For example, alcohol might be fully VAT-taxed (i.e. \( \text{LEX}_{\text{alcohol,domestic}} = 0 \)), but 10% of domestic alcohol producers may fail to register for VAT (i.e. \( \sum_{j} \text{SJ}_{\text{alcohol,j}} \times \text{REG} = 0.90 \)). Hence, via Equation \( \text{E14} \), \( \text{DEX}_{\text{alcohol,domestic}} = 0.10 \). Then, via Equation \( \text{E13} \), \( \text{EX}_{\text{alcohol,domestic}} = 0.10 \), allowing 10% of domestically produced alcohol to escape VAT. De facto VAT exemption may also arise on imported commodities. We denote the proportion of imports that are not declared for tax purposes by \( \text{IM}_{c} \). Continuing with our example, if all imported alcohol is legally imported (i.e. \( \text{IM}_{\text{alcohol}} = 0 \)) then, via Equations \( \text{E13} \) and \( \text{E15} \), \( \text{EX}_{\text{alcohol,import}} = 0 \). However, if 20% of alcohol is imported illegally, in the sense that it is undeclared to tax authorities, then \( \text{EX}_{\text{alcohol,import}} = 0.2 \).

Equation \( \text{E16} \) defines \( \phi^{(2)}_{c,s,k} \), the effective VAT refund rate on inputs of commodity \( c \) from source \( s \) into capital formation by industry \( k \). Equation \( \text{E16} \) recognizes that the effective refund rate for industry \( k \) depends not only on the legal refund rate allowed by the tax authority (\( \psi_{c,s,k} \)), but also on industry \( k \)'s registration rate, because only registered firms can claim credit on VAT paid on investment inputs.

Equation \( \text{E17} \) defines transaction-specific compliance rates (\( \text{CRT}_{c,s,u} \)) as the product of two shift variables: one transaction-specific (\( \text{FCRT}_{c,s,u} \)) and one economy-wide (\( \text{FCR} \)). Typically, in the initial calibration of the model, one of either \( \text{FCRT}_{c,s,u} \) or \( \text{FCR} \) will be endogenous, with the value of the other set exogenously at 1. Which of \( \text{FCRT}_{c,s,u} \) or \( \text{FCR} \) is determined endogenously depends on availability of actual VAT revenue information. If a full set of values for AVAT\(_{c,s,u}\) are available from the tax authority, then AVAT\(_{c,s,u}\) can be set exogenously at these known values, with \( \text{FCRT}_{c,s,u} \) and \( \text{FCR} \) exogenously set equal to 1. A more common scenario will be that information on aggregate VAT collections (AVATTOT) is available, but not information on AVAT\(_{c,s,u}\). In this case, AVAT\(_{c,s,u}\) and \( \text{FCR} \) will be endogenous, with AVATTOT exogenously set at its known value and \( \text{FCRT}_{c,s,u} \) exogenously set equal to 1. Another possibility is that AVATTOT and selected elements of AVAT\(_{c,s,u}\) are known. In this case, selected elements of AVAT\(_{c,s,u}\) (together with AVATTOT) can be set exogenously at known values, with endogenous determination of corresponding elements of \( \text{FCRT}_{c,s,u} \) and \( \text{FCR} \).

### IV. Parameterizing the VAT Model to Vietnam’s VAT System

We illustrate our VAT theory by applying it to the Vietnamese VAT system. Vietnam makes an interesting case study for at least two reasons. First, with its many rates and exemptions, Vietnam’s VAT system is arguably among the most complex in South East Asia (Giesecke and Tran, 2010). This complexity ensures that our Vietnamese implementation exercises many of the dimensions of the system described by Equations E1–E17. Second, existing estimates of CE for Vietnam are low. Our system helps explain why. In Section V, we compare our measure of VAT compliance (CR) to values for CE and its more refined variant, the VRR. We decompose the gap between CR and VRR into the individual contributions of the structural and statutory factors that characterize Vietnam’s VAT system. The computer implementation of our equation system uses the GEMPACK software (Harrison and Pearson, 1996).

Vietnam introduced a VAT in 1999. By 2005, the system had undergone much change, while still retaining a high degree of complexity. Vietnam’s VAT has three rates, many exemptions across different commodities and purchasers, and numerous limits on refunds on inputs to investment. The nature of Vietnam’s implemented VAT system is further complicated by the country’s economic structure, which is characterized by a high degree of multi-production and diverse VAT registration rates across industries.

To implement our VAT system, we require independent estimates for the system’s exogenous variables, namely \( \text{BASIC}_{c,s,u} \), \( \text{IM}_{c} \), \( \text{LEX}_{c,s,u} \), \( \text{LR}_{c,s,u} \), \( \psi_{c,s,k} \), \( \text{M}_{c,s,u} \), \( \text{NRI}_{j} \), \( \text{NRL}_{j} \), \( \text{SO}_{c,j} \), \( \text{SJ}_{c,j} \), \( \text{SS}_{c,u} \), \( \text{T}_{c,s,u} \), \( \phi^{(3)}_{c,s,u} \), \( \text{SHNRES}_{c,s} \), \( \text{FCRT}_{c,s,u} \) and AVATTOT.\(^{18}\)

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\(^{18}\)Estimates for AVAT\(_{c,s,u}\) are not available for Vietnam. However, the value of total VAT collections is available. Hence, we determine AVATTOT as an exogenous variable, with AVAT\(_{c,s,u}\) and \( \text{FCR} \) endogenous. All elements of \( \text{FCR}_{c,s,u} \) are exogenously set equal to 1.
Of these, BASIC\textsubscript{c,s,u}, M\textsubscript{c,s,u}, SO\textsubscript{c,j}, SJ\textsubscript{j} and SS\textsubscript{c,u} are readily calculated from national input–output data (General Statistics Office (GSO), 2007). All elements of FCRT\textsubscript{c,s,u} are set equal to 1. AVATTOT\textsubscript{c,s,u} is available from government finance statistics (Ministry of Finance, 2007). LEX\textsubscript{c,s,u}, LR\textsubscript{c,s,u}, \phi\textsubscript{c} and \psi\textsubscript{c,s,k} are determined by careful inspection of the tax code (National Assembly, 2003). T\textsubscript{c,s,u} is determined via inspection of both the tax code (to identify relevant taxes) and input–output statistics (to determine tax rates). Estimates for the remaining variables IM\textsubscript{c,s,u}, NRL\textsubscript{j} and SHNRES\textsubscript{c,s} must be developed from other data sources. In the following sections, we expand our discussion of the values for the model’s exogenous variables. Before doing so, we draw the reader’s attention to Tables 1 and 2. These tables summarize relevant features of Vietnam’s VAT system and economic structure, while abstracting from the details of our fully implemented system of VAT equations. Table 1 reports the key values that determine the outcome for the CR. The values reported in columns 1–8 are calculated by Equations E18–E38 as appropriate weighted averages and totals of values from the core equation system E1–E17. To aid our understanding of the values in Table 1, Table 2 reports the commodity composition of purchases by the four broad agents in our model, namely producers, investors, households and government.

### Legal VAT rates

Equations E18–E20 define average legal rates classified by broad economic agent (AVELR\textsubscript{q}). We report Vietnam’s AVELR\textsubscript{q} values in Table 1 (column 1).

Vietnam introduced VAT in January 1999. The VAT was initially levied at four rates: 0%, 5%, 10% and 20%. Since January 2004, the VAT rate structure has been simplified to three rates: 0%, 5% and 10%. Foreign sales attract the 0% rate. The 5% rate attaches to unprocessed agricultural commodities at the commercial trading stage, certain primary building materials, chemicals, fertilizers, pharmaceuticals, certain machinery, metal products, animal feed, publishing, water, road transport, rail transport, air transport, scientific services and cultural services. All other goods and services are taxed at 10%.

Average legal VAT rates differ across users, reflecting differences in the commodity composition of their purchases. The average VAT rate is lowest for government consumption (Table 1, row 4, column 1). This is because a high proportion of the consumption of nonexempt commodities consumed by government (such as scientific and cultural services) is taxed at a rate of 5%. Average rates are higher for households, investors and producers (Table 1, rows 1–3, column 1) because larger shares of their spending are on commodities that attract 10% VAT rates, such as mining, manufacturing and construction (Table 2).

### Legal exemption rates

The Vietnamese VAT code provides VAT exemptions for goods and services deemed either essential or important for economic development. These include raw agricultural materials, imported machinery and equipment used in R&D and capital formation, health and education services, public broadcasting, cultural events and sanitation works. Exemptions also apply to difficult-to-tax services, such as financial and dwellings services. Import sales of mining are explicitly declared VAT exempt, despite the zero rate applying to all export sales.

Equations E21–E23 calculate the average legal exemption rates (AVELEX\textsubscript{q}) for broad categories of commodity user. Table 1 (column 2) reports AVELEX\textsubscript{q} values for Vietnam. Average legal exemption rates differ across users because of differences in the commodity composition of their consumption. The Government has the highest average legal exemption rate (84%), reflecting high consumption of exempted services, such as education and health. Average legal exemption rates for producers and households are substantially lower, at around 20%. This reflects the comparatively high proportions of the total spending by these agents on manufactures, most of which are not VAT exempt. Investment has the lowest average legal exemption rate because a large share of investment spending is construction services, which is not VAT exempt.

### Nonregistration rates

As discussed in Section III, industry-specific registration rates are influenced by two factors: nonregistration for VAT purposes permitted under the VAT code; and nonregistration arising from informal activity. The rates of these two sources of nonregistration are represented by NRL\textsubscript{j} and NRL\textsubscript{i}, respectively (Equation E12). We discuss below how the initial levels of these variables were calculated for our Vietnam implementation.

Under the Vietnamese VAT code, individuals, households and enterprises conducting business in Vietnam are obliged to register for VAT. Because
Table 1. Summary measures of VAT rates and bases in Vietnam, 2005

| Users                | AVELR | AVELEX | AVEDEX | AVEEEE | AVEREF | See Table 2 | VATBASETOT | EVAT TOT |
|----------------------|-------|--------|--------|--------|--------|-------------|------------|----------|
| 1. Producers         | 8.0   | 24.1   | 14.6   | 27.3   | 75.0   | 1049.3      | 187.5      | 15.0     |
| 2. Investors         | 8.7   | 18.0   | 2.5    | 20.2   | 70.7   | 277.0       | 69.9       | 6.1      |
| 3. Households        | 8.7   | 20.4   | 27.9   | 33.9   | –      | 509.9       | 337.1      | 29.3     |
| 4. Government        | 6.4   | 84.3   | 3.1    | 85.8   | –      | 111.9       | 15.9       | 1.0      |
| 5. Economy-wide average or total | 8.4   | 25.7   | 15.7   | 31.4   | 74.1   | 1948.1      | 610.3      | 51.4     |
| 6. VAT collected on purchases by domestic nonresidents (EVATEXP) |       |        |        |        |        |             | 3.0        |          |
| 7. Actual VAT revenue |       |        |        |        |        |             |            | 45.9     |
| 8. Compliance rate (=7/(5 + 6)) |       |        |        |        |        |             |            | 0.844    |
VAT registration is generally compulsory,\(^\text{19}\) we set \(NRI_j = 0\).

Vietnam has many enterprises that choose to operate informally, failing to register for VAT, and not registering as businesses under other relevant statutes. We base our estimates for \(NRI_j\) on the size of the informal sector. However, by its nature, the size of the informal sector is difficult to measure. Estimates of Vietnam’s informal sector have ranged between 30% of GDP in 1995 (Nguyen Van Chinh, 2001) and 16% of GDP in 2005 (Schneider and Buehn, 2007).

There are no estimates of the informal sector at the industry level. However, we have industry-specific data on production by individual household businesses,\(^\text{20}\) and the proportion of these individual household businesses which have official registration as a business. We use the share of industry \(j\)’s activity produced by nonregistered individual household businesses as a proxy for the share of industry \(j\)’s activity produced by the informal sector.\(^\text{21}\) That is, we calculate the share of industry \(j\)’s output produced by informal enterprises (\(NRI_j\)) via

\[
NRI_j = SHIB_j \times SHNR_j
\]

where \(SHIB_j\) is the share of industry \(j\)’s output produced by individual household businesses; and \(SHNR_j\), the share of the individual household businesses in industry \(j\) that are not registered for business purposes. We base our \(SHIB_j\) and \(SHNR_j\) estimates on data from General Statistics Office (Vietnam) (GSO) (2005, 2006a, b).\(^\text{22}\)

Weighting our \(NRI_j\) estimates by industry output shares, we find the economy-wide average nonregistration rate is 22%. This is within the range of existing estimates of the size of the Vietnamese informal sector. At the sectoral level, nonregistration rates range from approximately 80% in agriculture, 20% in services, 10% in manufacturing, to below 3% for mining, construction and utilities.

Equations E24–E26 calculate economy-wide average de facto exemptions (\(AVEDEX_q\)) across broad user classes. Values for \(AVEDEX_q\) are reported in Table 1 (column 3). As can be seen from column 3, nonregistration generates de facto exemptions on purchases by all users. For example, if 83% of agricultural products are produced by nonregistered producers, then the de facto exemption rate for agricultural products is 83% for all users.

Equations E27–E29 calculate average effective rates of exemption on purchases by broad user classes (\(AVEEX_q\)). Values for \(AVEEX_q\) are reported in Table 1 (column 4). Via Equation E13 the effective exemption rate for any given commodity is the maximum of its legal exemption rate and its de facto (nonregistration generated) exemption rate. In Table 1, this accounts for why the average effective

| Sector                          | 1. Production | 2. Investment | 3. Households | 4. Government | 5. Total |
|---------------------------------|---------------|---------------|---------------|---------------|---------|
| 1. Agriculture                  | 155.6         | 0.7           | 78.0          | 1.8           | 236.1   |
| 2. Mining, manufacturing and construction | 798.7         | 265.0         | 276.5         | 5.1           | 1345.3  |
| 3. Services                     | 95.0          | 11.3          | 155.4         | 105.0         | 366.7   |
| Total                           | 1049.3        | 277.0         | 509.9         | 111.9         | 1948.1  |

\(^{19}\)The one exception to compulsory VAT registration is ‘household businesses’ with monthly income less than approximately US $22 per month. While there are no official data on either the number or importance of these businesses, we expect both to be small. In forming this view, we noted two things. First, as ‘household businesses’ we expect activity by such enterprises to represent very small shares of industry-specific activity levels. Second, the legislated threshold for VAT registration by such enterprises (US $22 per month) is very low – less than half average income per capita (US $52 per month). Hence, we expect very few household businesses to fall under this category, and to the extent they do, their existence (and influence on \(RE\)) will likely be captured in our \(NRI\) estimate.

\(^{20}\)An individual household business is a business of fewer than 10 employees that is owned by one individual or a household.

\(^{21}\)This is consistent with standard definitions of the informal sector, which is typically seen to consist of small-scale unincorporated enterprises owned by households (see, e.g. the definition of the informal sector in 1993 SNA (UN, 2001)).

\(^{22}\)For those industries classified as industrial, we base values for \(SHIB\) on data from GSO (2006a), which classifies output by industry into output produced by five types of enterprise (individual household businesses, state-owned enterprises, collective, private and enterprises with foreign capital). For industries in the agricultural and service sectors, we use data from the Vietnam Household Living Standard Survey 2004 (GSO, 2006b), defining \(SHIB\) as the share of industry \(j\)’s labour income that accrues to self-employed persons in industry \(j\). We calculate \(SHNR\), for industries in the industrial and service sectors using data from the Annual Nonfarm Household Business Survey (GSO, 2005), which provides information on the registration and tax payment status of individual household businesses. For industries in the agricultural sector, we base our \(SHNR\) estimate on the proportion of agricultural households operating in industry \(j\) that do not pay taxes, data for which are obtained from the VHLSS (GSO, 2006b).
exemption rate for each user (column 4) always exceeds the value of the simple average of the user's average legal exemption rate (column 2) and average de facto exemption rate (column 3).

**Refund rates for inputs into production and investment**

Equations E30 and E31 calculate weighted average rates of VAT credit paid on inputs to production and investment \((\text{AVEREF}_{\text{Producer}}\text{ and } \text{AVEREF}_{\text{Investor}},\text{ respectively})\). Values for \(\text{AVEREF}_{\text{Producer}}\text{ and } \text{AVEREF}_{\text{Investor}}\) are reported in Table 1 (column 5). On average, approximately 75% of VAT paid on inputs to production are refunded (Table 1, row 1, column 5). There are some additional limits on VAT credit to investment. For example, VAT credit is unavailable on inputs to housing construction, and use of specialized equipment and machinery in capital formation by public administration, health and education. Together, these additional credit limits cause the average refund rate on inputs to investment, at 70%, to be lower than that for inputs to production (Table 1, row 2, column 5).

**VAT bases and expected VAT liabilities**

Equations E32–E34 calculate values for aggregate VAT bases classified by broad user type \((\text{VATBASETOT}_i)\). Equations E35–E38 calculate expected VAT revenue accruing on purchases by broad user type \((\text{EVATOT}_i\text{ and } \text{EVATEXP})\). Values for \(\text{VATBASETOT}_i\) and \(\text{EVATOT}_i\) are reported in columns 7 and 8, respectively, of Table 1. The value of expected revenue on export sales \((\text{EVATEXP})\) is reported in row 6. As can be seen from columns 7 and 8, the incidence of VAT falls not only on final consumption, but also on production and investment. The expected VAT revenue on final consumption accounts for just over 50% of total expected VAT revenue.\(^{23}\) The remaining expected VAT revenue accrues on sales to production, investment and exports, accounting for 28%, 11% and 5% of the total expected VAT revenue, respectively.

**V. From CE To CR: Decomposing the Difference Between Vietnam’s Indices of CE and CR**

In 2005, total Vietnamese VAT revenue was VND 45.9 trillion, the value of final consumption was VND 649.2 trillion and the value of VAT-exclusive final consumption was VND 621.8 trillion. Hence, Vietnam’s CE index was 0.71 (=45.9/649.2 x 0.10).\(^{24}\) The country’s VRR was 0.74 (=45.9/621.8 x 0.10). As indicators of Vietnamese VAT compliance, these indices are low and misleading. As we shall discuss further in this section, the application of Equations E1–E17 to Vietnam produces a CR value of 0.84. This is a full 10 percentage points higher than the VRR index because the CR calculation takes account of the statutory and structural features of Vietnam’s VAT system. In this section, we investigate the gap between Vietnam’s VRR and CR indices, exploring the individual contributions of multiple rates, exemptions, registration rates, investment input credits and taxation of nonresidents. In doing so, we use the decomposition algorithm of Harrison et al. (2000) as implemented in the GEMPACK software (Harrison and Pearson, 1996).\(^{25}\) We begin by parameterizing

\(^{23}\) =29.3/(51.4 + 3.0).

\(^{24}\) Bird and Gendron (2007) report a much lower CE ratio for Vietnam in the period 1998 to 2000, at 0.56. The difference is likely due to low compliance at the time of the Bird and Gendron study, when the tax was still very novel for both tax payers and tax authorities (Vietnam introduced the VAT in 1999).

\(^{25}\) For the case of one endogenous variable, \(Z\), Harrison et al. (2000) summarize their decomposition algorithm as follows. Assume \(Z\) can be expressed as a function of \(n\) exogenous variables \(X_1, X_2, \ldots, X_n\); \(Z = f(X_1, X_2, \ldots, X_n)\). Next, assume that the vector of exogenous variables \(X = (X_1, X_2, \ldots, X_n)\) moves along some path, beginning at \(X_{\text{INITIAL}}\) and ending at \(X_{\text{FINAL}}\).

\[
X_{\text{INITIAL}} = (X_{10}, X_{20}, \ldots, X_{n0})
\]

\[
X_{\text{FINAL}} = (X_{11}, X_{21}, \ldots, X_{n1}) = (X_{10} + \Delta X_1, X_{20} + \Delta X_2, \ldots, X_{n0} + \Delta X_n)
\]

Assume that the shocks are divided into \(h\) equal instalments. Provided \(h\) is sufficiently large, the effect of applying the 1/\(h^\text{th}\) instalment of the total shock can be accurately approximated by

\[
dZ = f_1 dX_1 + f_2 dX_2 + \ldots + f_n dX_n, \quad \text{where } f_i = \frac{\partial f}{\partial X_i} \text{ and } dX_i = \Delta X_i/h
\]

If \(h\) is sufficiently large (i.e. the \(dX_i\) are sufficiently small) then the approximation will be exact and the right-hand side terms provide a decomposition of the total change \(dZ\) for the first instalment of the shock. Going on to apply the remaining \(h-1\) instalments of the shocks, the \(f_i\) depend on the value of \(Z\) and \(X\) at each step, and so change with each step. This provides no additional computational burden for GEMPACK, since updated values for the \(f_i\)'s are required for the standard GEMPACK solution algorithm. Finally, the contribution made by each shock \(\Delta X_i\) to the total change in \(Z\) \((\Delta Z)\) is the sum of the \(h\) results for \(f_i dX_i\). In the above example, and in the algorithm implemented in GEMPACK by Harrison et al., exogenous variables are assumed to move on a straight line path from their pre- to post-simulation values. Other paths may be possible, but as Harrison et al. argue, a straight-line path will typically be the most natural choice from among the many possible paths.
our VAT model in a way that reflects the implicit assumptions of the VRR calculation. The VRR-implicit values for the exogenous variables are

\[
\begin{align*}
LR_{c,t,v} &= 0.10 \quad (c \in M, s \in S, v \in V) \\
LR_{s, \text{exports}} &= 0 \quad (c \in M, s \in S) \\
LEX_{c,s,u} &= 0 \quad (c \in M, s \in S, u \in U) \\
\psi_{c,s,k} &= 1 \quad (c \in M, s \in S, k \in K) \\
NRI_{j} &= 1 \quad (j \in N) \\
NRL_{j} &= 0 \quad (j \in N) \\
IM_{c} &= 0 \quad (c \in M) \\
\phi^{(3)}_{c} &= 1 \quad (c \in M)
\end{align*}
\]

With our VAT model parameterized in this way, we find \( CR = 0.74 \). That is, our full VAT model begins by exactly reproducing the crude VRR value. Next, we run a simulation in which we move values for relevant variables to their true values. In particular, we move \( LEX_{c,s,u} \), \( LR_{c,s,v} \), \( \psi_{c,s,k} \), \( NRI_{j} \), \( NRL_{j} \), \( SHNRES_{c,s} \) and \( \phi^{(3)}_{c} \) from their VRR-implicit values, to their true values.26 In doing so, we employ the decomposition method of Harrison et al. (2000) to identify the individual contributions of each of these exogenous variables to the gap between Vietnam’s VRR index and its CR index.

Table 3 presents a summary of our decomposition simulation. Column (1) summarizes the pre-simulation status of the model, with exogenous variables set at values that replicate implicit VRR assumptions. With exogenous variables set at their VRR-implicit values, the aggregate VAT base for domestic purchasers is VND 621.8 trillion (column 1, row 6). With all legal rates set at 0.10, expected VAT revenue is VND 62.2 trillion and the value for CR is 0.74.

Our simulation involves moving the values for \( LEX_{c,s,u} \), \( LR_{c,s,v} \), \( \psi_{c,s,k} \), \( NRI_{j} \), \( NRL_{j} \), \( SHNRES_{c,s} \) and \( \phi^{(3)}_{c} \) from their VRR-implicit values to their true values. This changes the values for the model’s endogenous variables, including VAT bases (\( VATBASE_{c,s,u} \)), expected VAT revenue (\( EVATTOT \)) and the outcome for our economy-wide compliance measure, CR. Results for these variables are summarized in Table 3. The decomposition simulation allows the outcomes for these variables to be decomposed into the individual contributions made by the movements of each of the exogenous variables from their VRR-implicit values to their true values. In our simulation, over a hundred thousand exogenous variables are shocked; hence, some aggregation is necessary for reporting purposes. This is achieved by aggregating the individual effects of each of the exogenous shocks within five groups of related variables. These groups correspond to columns 2–6 of Table 3. Each column shows the effects of a group of shocks to the endogenous variables in isolation of the effects from other groups of shocks.27

26 We have no estimates for \( IM_{c} \) for Vietnam. Hence, we leave \( IM_{c} = 0 \) in our simulation.

27 Note, however, that in a multi-step Euler computation, the effects of shocks in each column are largely, but not completely, independent of shocks in other columns. The decomposition algorithm calculates an exogenous variable’s contribution to the total outcome for a given endogenous variable by summing its contributions as it moves along a path from its pre- to post-shock value. This requires, along this path, continuous re-evaluations of the endogenous variable’s elasticity to the exogenous variable in question. These elasticities will be somewhat dependent on movements in other shocked variables. Hence, the effects of a given shock in a given column are largely, but not completely, independent of shocks in other columns. This is apparent in the results for the effects of shocks on the weighted average of legal rates (row 1, Table 3). The legal rate shown on this row is the economy-wide average VAT rate, weighted by the base of the VAT. One might expect that the introduction of legal exemptions, nonregistration and investment input refunds would have no effect on the average legal rate. That is, the values in columns 3–6, row 1, are expected to be zero. We see this outcome in columns 4–6, but not column 3. Row 1, column 3, differs slightly from zero because the VAT base changes significantly in this column. This affects the weighting regime underlying the calculation of \( AVELRTOT \).
Table 3. Decomposition of the VRR–CR gap for Vietnam

| Description               | Name               | (1)   | (2)    | (3)    | (4)    | (5)    | (6)    | (7)     |
|---------------------------|--------------------|-------|--------|--------|--------|--------|--------|---------|
| I. Rates                  | AVERELRTOT         | 0.10  | -0.015 | -0.001 | 0.000  | 0.000  | 0.000  | 0.084   |
|                           | AVELEXTOT          | 0.000 | 0.000  | 0.257  | 0.000  | 0.000  | 0.000  | 0.257   |
|                           | AVEDEXTOT          | 0.000 | 0.000  | 0.000  | 0.157  | 0.000  | 0.000  | 0.157   |
|                           | AVEEXTOT           | 0.000 | 0.000  | 0.219  | 0.095  | 0.000  | 0.000  | 0.314   |
|                           | AVEREFTOT          | 1.000 | 0.000  | -0.094 | -0.149 | -0.016 | 0.000  | 0.741   |
| II. Values (VND trillion) | VATBasetot         | 621.8 | 0.00   | -55.4  | 22.8   | 21.1   | 0.00   | 610.3   |
|                           | VATBasetot_1producers | 0.00 | 0.00  | 73.6   | 113.9  | 0.00   | 0.00   | 187.5   |
|                           | VATBasetot_1investors | 0.00 | 0.00  | -4.6   | 53.5   | 21.1   | 0.00   | 69.9    |
|                           | VATBasetot_1households + VATBasetot_1government | 621.8 | 0.00 | -124.4 | -144.5 | 0.00 | 0.00 | 352.9 |
|                           | EVATTOT            | 62.2  | -9.97  | -5.8   | 1.91   | 2.10   | 3.90   | 54.3    |
|                           | VATTOT             | 45.9  | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 45.9    |
|                           | CR                 | 0.738 | 0.123  | 0.075  | -0.020 | -0.025 | -0.047 | 0.844   |

A general framework for measuring VAT compliance rates
In moving LR_{c,s,u} to their true values, AVELRTOT (Vietnam’s weighted-average legal VAT rate; Equation E39) falls by 1.5 percentage points (row 1, column 2). With column 2 isolating the effects of moving LR_{c,s,u} to their true values, we see no changes in the values of AVELEXTOT, AVEDEXTOT, AVEEXTOT, AVEREFTOT and VATBASETOT (rows 2–6, column 2). However, expected VAT revenue (EVATTOT) falls by approximately VND 10 trillion (row 7, column 2). This explains over 12 percentage points of the gap between the VRR and CR measures (row 9, column 2).

The Harrison et al. (2000) decomposition allows the results in column 2 to be decomposed further: indeed, as far as the individual contribution of the movement in each element of LR_{c,s,u}. We suppress this detail here. However, we noted below the main contributors to the column 2 result.

Most agricultural commodities attract VAT at 5%. Hence, agricultural commodities have the largest difference between VRR-implicit and actual values for LR_{c,s,u}. However, agricultural commodities make up less than 13% of the final consumption base (Table 2, columns 3 and 4). As such, nonstandard VAT rates on agriculture explain about –0.6 percentage points of the –1.5 percentage point movement in AVELRTOT, and thus explain over one-third of the 12.3 percentage point contribution of nonstandard legal rates to the difference between VRR and CR.

Nonstandard VAT rates on certain manufactured goods make the largest contribution to the fall in AVELRTOT. A number of important consumption items, such as sugar, pharmaceuticals, chemical products, printing and publishing products, are taxed at the concessional rate of 5%, not the standard rate of 10%. In moving LR_{c,s,u} to their true values, the average VAT rate on manufactures falls by 1.6 percentage points. Manufactured products represent about 45% of the total final consumption base for VAT (Table 2, row 2, columns 3 and 4). Hence, the fall in the average VAT rate on manufactures explains about –0.8 percentage points of the –1.5 percentage point movement in AVELRTOT, and thus accounts for about half of the 12.3 percentage point contribution of nonstandard legal rates to the difference between VRR and CR.

The proportion of services that attract the 5% VAT rate is relatively small, at about 8% of service sales to final consumption. Concessional VAT rates on services explain about –0.2 percentage points of the column 2 result for AVELRTOT. This accounts for just under one sixth of the 12.3 percentage point contribution of nonstandard legal rates to the difference between VRR and CR.

Legal exemptions

In column 1 of Table 3, values for LEX_{c,s,u} are set at their VRR-implicit rate of 0. Column 3 reports the effects of moving LEX_{c,s,u} to their true values. This raises the value of the average legal exemption rate (AVELEXTOT) by 0.26 (row 2, column 3). Inspecting the results across row 4 of Table 3, we see that legal exemptions account for about two-thirds of the value of Vietnam’s average effective exemption rate.

Legal VAT exemptions have two opposing effects. On the one hand, they reduce the VAT final consumption and investment base, because households, government and investors do not have to pay VAT on exempt commodities (rows 6b–6c, column 3). On the other hand, they expand the tax base on inputs to production, because producers of exempt goods can no longer claim VAT paid on inputs used to produce those goods (row 6a, column 3). For Vietnam, the first effect is larger than the second. With education, health care, water, dwellings and components of many other services exempt, the VAT base for final consumption is reduced by 20%. The VAT base for intermediate input purchases increases from 0% to about 12% of the total final VAT base. The combined effect is a reduction in the VAT base of 9%. This causes CR to rise by 7.5 percentage points.

Nonregistration for VAT purposes

Column 4, Table 3 reports the effects of introducing nonregistration for VAT purposes due to informal business activity (NRI). This proves a relatively unimportant part of Vietnam’s VAT compliance story, explaining only –2 percentage points of the gap between Vietnam’s VRR and CR index values (row 8, column 4).

The direct effect of the introduction of VAT nonregistration is to change the effective exemption rates (Equation E13). As discussed in the Section ‘Nonregistration rates’, nonregistration rates are nonzero for most industries, and very high in agriculture and certain services, such as trade,
restaurants and miscellaneous services. The de facto exemption rates due to nonregistration exceed the legislated exemption rates for most commodities. Overall, the average effective exemption rate is increased by 9.5 percentage points (row 4, column 4, Table 3). The increase in effective exemption rates has two opposing effects: while increasing the VAT base for intermediate inputs, it decreases the final consumption VAT base. The intermediate input and investment VAT bases expand by just over VND 165 trillion (rows 6a and 6b, column 4), because of the increase in effective exemption rates for agriculture and manufacturing. The final consumption VAT base falls (row 6c) because effective exemptions increase on agricultural and manufacturing commodity sales. Important components of final consumption, such as education, health care and public administration, are already fully exempted in column 3. Nonregistration rates in these industries are small, and thus effective exemption rates for the commodities produced by these industries are unchanged. Overall, accounting for nonregistration causes a small net expansion in the aggregate VAT base (row 6, column 4). This generates a small net expansion in expected VAT revenue (row 7, column 4), making a negative contribution to the gap between the VRR and CR indices (row 9).

Informal business arrangements might arguably be viewed as a form of noncompliance. For example, Sookram et al. (2009) find that the desire to avoid taxes can be a motivation for participation in the informal sector. Some readers may wish to calculate CR under this assumption (hereafter, CR2). This can be done by setting NRI\(c\) (and IM\(c\)) at 0. With NRI\(j\)=IM\(j\)=0, our calculation of expected VAT revenue (EVATTOT) now assumes no informal activity either in production or imports, and as such, the value for CR2 calculated by Equation E6 will effectively embody the effects of informal activity. Note that the results in Table 3 allow us to calculate CR2. Column (4) reports the impact of moving the value of NRI\(j\) from 0 to its true value. Hence, by subtracting the result at row 9, column 4 (−0.020) from the final value for CR (0.844) we obtain the value for CR2 (0.864). The reader will note that, for Vietnam, CR2>CR. Setting NRI\(j\) equal to zero has two countervailing effects on the difference between CR and CR2. On the one hand, the effective exemption rate falls, increasing expected VAT revenue. On the other hand, expected VAT revenue on inputs to production and investment falls, because registered firms can reclaim VAT paid on inputs. As discussed above, the latter effect is larger than the former, causing CR2>CR.\(^{32}\)

\[^{32}\text{While NRI}_j\text{’s contribution to the noncompliance rate may be ambiguous, this will not be the case for informal imports (IM},_j\text{). In moving between the CR and CR2 measures, we must move IM},_j\text{ from its true value to 0. Via Equations E15 and E13 this reduces effective exemption rates, increasing expected VAT revenue, and thus lowering CR2 relative to CR. The reader will note that there is no column for IM}_j\text{ in Table 3. This is because for Vietnam we have no estimates for IM}_j\text{, and hence we leave the value of IM}_j\text{ on its VRR-implicit value of 0 in our decomposition simulation.}\]

\[^{33}\text{Vietnam does not have a VAT refund scheme for domestic nonresident purchases, hence the true value for } \phi}_c^{(3)}\text{ is 0. Vietnam began considering such a scheme in 2009, as a means of promoting tourism (Vietnamese Communist Party, 2010).}\]

\[\text{VAT refund exclusions on selected inputs to capital formation}\]

Column 5, Table 3 reports the effects of VAT refund exclusions on selected inputs to capital formation in the health, education, defence and dwellings sectors. These exclusions expand the VAT base by VND 21 trillion (Table 3, row 6, column 5). Nonrefundability of VAT on inputs to dwellings construction alone increases the VAT base by approximately VND 20 trillion. The remaining increase in the VAT base (VND 1 trillion) is due to VAT refund exclusions on selected inputs to capital formation in the health, education and defence sectors. The increase in the VAT base causes expected VAT liabilities to rise (row 6, column 5), reducing the gap between the VRR and CR indexes (row 8, column 5).

\[\text{VAT on domestic nonresident purchases}\]

Column 6, Table 3 reports the effects of levying VAT on domestic purchases by nonresidents. In terms of our decomposition shocks, this is represented by moving \(\phi}_c^{(3)}\) from its VRR-implicit value of 1 to its true value of 0.\(^{33}\) Since Vietnam does not levy VAT on foreign sales, LR\(_{c,s,\text{exports}}\) remains on its VRR-implicit value of 0. Just as the VRR measure makes no allowance for VAT collection on export sales, with \(\phi}_c^{(3)}\) initially equal to 1, and LR\(_{c,s,\text{exports}}\) initially equal to 0, the possibility of VAT collections on export sales is eliminated from Equation E3. By moving the value of \(\phi}_c^{(3)}\) to its true value, we instate in Equation E3 the possibility of VAT collections from export sales. In particular, spending by foreigners visiting Vietnam for tourism, conferences and business is an important part of Vietnam’s export income. In 2005, expenditure by foreign visitors was approximately VND 46 trillion, which comprised about 8% of total exports, or 5.5% of GDP (GSO, 2006c). Major items of expenditure by foreign visitors include hotels, food, transport, shopping and services.
When purchasing these commodities, foreign visitors face the same VAT rates and effective exemptions as Vietnamese households. Our VAT model estimates total VAT liabilities on domestic purchases by nonresidents at VND 3.9 trillion (Table 3, row 7, column 6). This accounts for −4.7 percentage points of the gap between the VRR and CR measures (row 9, column 6).

VI. Concluding Remarks

This article presents a formal and comprehensive framework for modelling VAT. Our VAT system incorporates details of both VAT tax code and the economic structure on which VAT is applied. The framework is easy to apply to any country with national accounts, government finance and input–output data. In this article, we employ the system as a means of calculating a more informative index of average tax compliance (CR) than such commonly used measures as CE, VP and VRR. However, our system not only calculates an economy-wide average CR, but data permitting, also provides for estimation of CRs at a highly disaggregate level, namely by commodity, source and user. This more detailed CR information could be of value to tax authorities in identifying problem areas and targeting their enforcement efforts more effectively.

We apply our VAT system to the case of Vietnam. Our calculations show that the CR in Vietnam in 2005 was 84%. This is much higher than the 71% implied by the crude CE index. A well-known limitation of the CE index is that it does not account for many of the characteristics of real-world VAT systems. In the case of Vietnam, these features include differential VAT rates, many exemptions, nonregistration of businesses in the informal sector, and numerous legislated limits on investment input credits. Naturally, like all applied work, our CR calculations for Vietnam are subject to a number of caveats. By nature, the informal sector is difficult to measure. However, a strength of our system is that by defining variables like NRI and IM, assumptions about the extent of informality in production and imports are made explicit.

Our VAT framework facilitates a decomposition of the gap between the CE and CR index values. In the case of Vietnam, much of this gap is due to the proliferation of both nonstandard VAT rates and legal exemptions. Nonregistration of businesses for VAT purposes, and limits on VAT credit for investment, contribute relatively little to the gap between the CE and CR measures. This suggests that raising legal rates and removing or reducing legislated exemptions might be an effective way of raising VAT revenue. This possibility could be explored more rigorously by embedding our VAT system within a larger economy-wide model, such as a CGE model. For example, Giesecke and Tran (2010) embed a smaller example of such a system within a large-scale CGE model to explore the consequences of equalization of VAT rates at a single revenue-neutral rate. With Equations E1–E17 embedded in a CGE model, a number of variables that are presently exogenous (in particular, BASIC, M, SO, SJ, SS and AVATTOT) would become endogenous. The initial value of FCR would be set exogenously at a value that ensured that Equations E1–E17 produced a value for AVATTOT that conformed with government finance statistics. With Equations E1–E17 embedded in a CGE model, many interesting simulations become possible. These would include exploring the economy-wide and distributional effects of moving to higher CRs, and exploring the consequences of higher registration rates as the economy develops.

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References

Agha, A. and Haughton, J. (1996) Designing VAT systems: some efficiency considerations, Review of Economics and Statistics, 78, 303–8.

Aizenman, J. and Jinjarak, Y. (2008) The collection efficiency of the value added tax: theory and international evidence, Journal of International Trade and Economic Development, 17, 391–410.

Bird, R. M. and Gendron, P.-P. (2007) The VAT in Developing and Transitional Countries, Cambridge University Press, Cambridge.

Cnossen, S. (1990) Taxing value added: the OECD experience, International VAT Monitor, 5, 2–16.

Camen, S. (1990) Taxing value added: the OECD experience, International VAT Monitor, 5, 2–16.

de Mello, L. (2009) Avoiding the value added tax: theory and cross-country evidence, Public Finance Review, 37, 27–46.

34 National accounts and input–output data for many countries are available from the GTAP database. The GTAP 7.1 database, for example, contains input–output data for more than 90 countries (Source: https://www.gtap.agecon.purdue.edu/databases/regions.asp?Version = 7.312).
Ebrill, L., Keen, M., Bodin, J.-P. and Summers, V. (2001) *The Modern VAT*, International Monetary Fund, Washington, DC.

Gebauer, A., Nam, C. W. and Parsche, R. (2007) Can reform models of value added taxation stop the VAT evasion and revenue shortfalls in the EU?, *Journal of Economic Policy Reform, 10*, 1–13.

Gebauer, A. and Parsche, R. (2003) Evasion of value-added taxes in Europe: IFO approach to estimating the evasion of value-added taxes on the basis of national accounts data (NAD), *CESifo DICE Report, 2*, 40–4.

General Statistics Office (Vietnam) (GSO) (2005) The Non-farm Individual Business Establishment Survey. General Statistics Office, Vietnam. Available at http://www.gso.gov.vn (accessed 5 August 2008).

General Statistics Office (Vietnam) (GSO) (2006a) Industrial output value at current prices by ownership. Available at http://www.gso.gov.vn (accessed 5 August 2008).

General Statistics Office (Vietnam) (GSO) (2006b) Vietnam Household Living Standard Survey 2004. Available at http://www.gso.gov.vn (accessed 5 August 2008).

General Statistics Office (Vietnam) (GSO) (2006c) Tourist Expenditure Survey in 2005. Available at http://www.gso.gov.vn (accessed 3 January 2009).

General Statistics Office (Vietnam) (GSO) (2007) Input-output tables for 2005. GSO data for UNDP-funded Project VIE/03/101 ‘Strengthening capacity in financial policy analysis for human development’, General Statistics Office, Hanoi.

General Statistics Office (Vietnam) (GSO) (2008) Establishment Census of Vietnam 2007. Available at http://www.gso.gov.vn (accessed 9 February 2010).

Giesche, J. A. and Tran, H. N. (2010) Modelling value-added tax in the presence of multi-production and differentiated exemptions, *Journal of Asian Economics, 21*, 156–73.

Harrison, W. J., Horridge, J. M. and Pearson, R. K. (2000) Decomposing simulation results with respect to exogenous shocks, *Computational Economics, 15*, 227–49.

Harrison, W. J. and Pearson, R. K. (1996) Computing solutions for large general equilibrium models using GEMPACK, *Computational Economics, 9*, 83–127.

HM Revenue & Customs (2004) VAT refunds for travelers departing from the European Community (EC), Notice 704/1 (September 2004), London. Available at http://customs.hmrc.gov.uk (accessed 9 February 2010).

HM Revenue & Customs (2010) Measuring tax gaps 2009, London. Available at http://www.hmrc.gov.uk/stats/measuring-tax-gaps.pdf (accessed 9 February 2010).

Hybka (2009) VAT collection efficiency in Poland before and after accession to the European Union – a comparative analysis, *Ekonómia, 85*, 7–18.

Jack, W. (1996) The efficiency of VAT implementation: a comparative study of Central and Eastern European countries in transition, IMF Working Paper No. WP/96/79, International Monetary Fund.

Keen, M. and Smith, S. (2006) VAT fraud and evasion: what do we know and what can be done?, *National Tax Journal, 59*, 861–87.

Matthews, K. (2003) VAT evasion and VAT avoidance: is there a European Laffer curve for VAT?, *International Review of Applied Economics, 17*, 105–14.

Ministry of Finance (2007) Final accounts of stage budget balance FY 2005. Available at http://www.mof.gov.vn (accessed 10 December 2009).

National Assembly (2003) Law on amendment of the law on value added tax. Available at http://vbpq.mof.gov.vn/home.aspx (accessed 2 June 2007).

Nguyen Van Chinh (2001) Some issues in estimation of some integrated indicators and compilation main accounts in Vietnam, Country report for concluding workshop on RETA 5874: Rebasing and Linking of National Account Series in Selected Development Member Countries (DMCs) to be held from 13 to 16 February 2001 in Bangkok, Thailand. Available at http://www.adb.org/statistics/RLNAS/CW_CP_Vie.pdf (accessed 5 August 2008).

OECD (2008) Consumption Tax Trends 2008: VAT/GST and Excise Rates, Trends and Administration Issues, OECD, Paris.

Sandford, C. T. (1989) *Administrative and Compliance Costs of Taxation*, Fiscal Publications, Bath.

Sandford, C. T. (1995) *Tax Compliance Costs: Measurement and Policy*, Fiscal Publications, Bath.

Schneider, F. (2005) Shadow economies around the world: what do we really know?, *European Journal of Political Economy, 21*, 598–642.

Schneider, F. and Buehn, A. (2007) Shadow economies and corruption all over the world: revised estimates for 120 countries, *Economics: The Open Access, Open Assessment E-Journal, 1*, 2007–2009. Available at http://www.economics-ejournal.org/economics/journalarticles/2007-9 (accessed March 2010).

Sookram, S., Watson, P. K. and Schneider, F. (2009) Characteristics of households in the informal sector of an emerging economy, *Applied Economics, 41*, 3545–59.

Swedish National Tax Agency (2008) Tax gap map for Sweden: how was it created and how can it be used?, Swedish National Tax Agency, Solna.

United Nations (2001) *1993 System of National Accounts*, United Nations, Washington, DC. Available at http://unstats.un.org/unsd/sna1993/introduction.asp (accessed 7 April 2004).

Vietnamese Communist Party (2010) Tourism stimulus program to be launched, Online Newspaper. Available at http://www.dangcongsan.vn/cpv/ (accessed 8 April 2010).