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Radoslaw Stefanski and Gerhard Toews

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info: econ@st-andrews.ac.uk

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What's in a wedge? Misallocation and Taxation in the Oil Industry.[*]

Radoslaw (Radek) Stefanski[†] Gerhard Toews[‡]

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Abstract

Resource misallocation explains a large part of cross-country productivity differences. Measuring differences in marginal revenue products of labor and capital across countries and firms allows for a quantification of the extent of this misallocation, but is typically uninformative of its source. We address this problem by using novel, firm-level data from the oil industry. We confirm the existence of sizeable gaps in marginal revenue products across countries and firms relative to the US, but show that these disappear once we account for revenue taxation. Differences in tax policies are thus sufficient to account for cross-country gaps in marginal products.

Keywords: Misallocation, Productivity Differences, Taxation, Oil
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[†]University of St Andrews, School of Economics and Finance, and Oxford Centre for the Analysis of Resource Rich Economies, Dept of Economics, University of Oxford: rls7@st-andrews.ac.uk

[‡]New Economic School, Moscow, and Oxford Centre for the Analysis of Resource Rich Economies, Dept of Economics, University of Oxford: gtoews@nes.ru

1 Introduction

The misallocation of capital and labor across firms explains an important part of cross-country productivity differences (Restuccia and Rogerson, 2017). Hsieh and Klenow (2009), for example, attribute 30-60% of differences in productivity between China and India relative to the US to a misallocation of factor inputs across firms.

The extent to which inputs are misallocated can be inferred by examining the differences in marginal revenue products of individual inputs across countries and firms. The marginal revenue product (MRP) of an input is defined as the increase in a firm's total revenue attributable to employing an additional unit of that input. A firm wishing to maximize profits will increase the use of an input until its MRP is just equal to the cost of that input. Paraphrasing Hsieh and Klenow (2009), consider an economy with two firms with identical technologies in which one firm with political connections benefits from subsidized credit while the other firm can only borrow from financial markets at a higher cost. If we assume that both firms equate their MRPs of capital with their firm-specific interest rates, the MRP of capital of the firm with access to subsidized credit will be lower. This is a classical example of capital misallocation since the combined output of both firms would be higher if capital were reallocated from the firm with a low MRP to the firm with a high MRP.

There are potentially multiple explanation for the existence of differences (or 'wedges') in MRPs across firms (Restuccia and Rogerson, 2017). These may include variations in trade or transportation costs, borrowing constraints, institutional frameworks or differences in geography and climate. A more direct factor influencing input costs is the variation in taxation. If, for example, a firm operates two otherwise identical plants within different capital tax regimes, the MRP of capital will be higher in the high-tax regime and lower in the low-tax regime.

This paper aims to shed light on the source of wedges in MRP by focusing on a globally operating industry in which profit maximizing firms allocate inputs across a large number of countries. To do so, we proceed in two steps. First, we construct a simple heterogenous firms model in the spirit of Hsieh and Klenow (2009). Second, we use a proprietary database of the oil and gas industry from the consultancy Wood Mackenzie. This database contains information on revenues, capital costs, labor costs and - crucially - tax expenditures for all major oil and gas firms at the country-concession-firm level for more than 3 decades. Combining theory and data, we calculate the MRPs of labor and capital at the country-concession-firm level before and after accounting for tax policies. We then compare the distribution of MRPs in our benchmark country - the United States - to the corresponding distributions of MRPs in the rest of the world.

We find that the MRPs of labor and capital are both higher on average and more dispersed in the rest of the world than in the US. However, once we account for our measure of taxation, the differences in MRP distributions in the US and the rest of the world disappear completely. Thus, we find that the variation in observable tax policies is sufficient to account for all the observed variation in MRP wedges. Extending our analysis to the firm level, we show that our results are primarily driven by firms in the private sector.

Our results do not pin down the direction of causality between taxes and implicit wedges, and the paper remains agnostic in this respect. Our findings however are consistent with two interpretations. First, we can view taxes as causing the large variation in MRP observed in the data. This would be in line with the work of, for example, Prescott (2004) who finds that differences in the effective marginal tax rate on labor income in Europe and the US were key drivers of differences in labor supply across the two regions. More recently, McGrattan (2012) shows that changes in capital taxation played an important role in driving the Great Depression in the US, whilst Fajgelbaum et al. (2018) demonstrate that variation in state taxes generates spatial misallocation in the US. In our context, this direction of causation would suggest that harmonizing taxes across countries would entirely eliminate observed differences in MRPs across countries by reducing factor misallocation and hence contribute to higher aggregate productivity within the oil sector.

Second, our result is also consistent with the notion that equilibrium tax rates may themselves be endogenous and emerge as a consequence of careful negotiations between governments and firms who take those distortions into account. Stroebel and Van Benthem (2013) for instance show that the negotiated levels of taxation between firms and countries depends on a country's cost of expropriation and a firm's expertise in production. Jaakkola, Spiro and Benthem (2016) show that commitment problems on the side of the government can give rise to cyclical taxation rates in oil-rich countries, whilst Cust and Harding (2014) provide evidence that firm drilling activity across countries depends not only on geology but also on institutional quality which is reflected in taxation. In line with this research, our results suggest that the observed variation in direct revenue taxation appears sufficient to explain differences in investment.

This paper is most closely related to the literature concerned with cross-country productivity differences, the measurement of such differences and the effect the elimination of such differences might have on output. Using data for the US, Restuccia and Rogerson (2008) show that policies which result in an increase in heterogeneity of prices faced by different producers can lead to large decreases in output per capita. Hsieh and Klenow (2009) use microdata on manufacturing firms to quantify the potential extent of misallocation in China and India using the US as the reference point. Using micro data for the agricultural sector Gollin, Lagakos and Waugh (2014) provide evidence for large productivity gaps across countries. These results are in line with Restuccia, Yang and Zhu (2008) who demonstrate that barriers to the movements of labor and intermediate goods across sectors can lead to large sectoral productivity gaps. Using publicly available macroeconomic data Caselli and Feyrer (2007) do not find significant differences in marginal revenue product of capital across countries arguing that the output gains form a reallocation of capital will be limited. More recently, Monge-Naranjo, Sánchez and Santaeulalia-Llopis (2016) relax the assumption made by Caselli and Feyrer (2007) by introducing a new methodology. In contrast to the latter, they find evidence for a significant degree in misallocation of physical capital and, consequently, estimate the gains from a capital reallocation to be large across countries. This literature thus provides strong evidence suggesting the existence of large wedges in MRPs across firms and countries while only little has been said about the source of such wedges. We use data from a globally operating industry to contribute to this literature.

We proceed as follows. In section 2 we construct a simple model which allows us to to extract concession-level wedges to MRP, before and after accounting for taxes. In section 3 we present our data. In section 4 we estimate the wedges and discuss the results before we conclude.

2 Model

In this section we sketch a simple span-of-control model which we will use to measure the extent of misallocation of inputs across concessions in the oil sector. By specifying the production structure of firms we can infer variation in marginal revenue productivities, which in turn allows us to measure the size of distortions or wedges at each concession - both before and after accounting for taxation. Importantly, to extract these implicit wedges we do not need to specify a full model - we only need to specify the firm side.[1]

Firms Suppose that there are F firms indexed by $f = 1, \ldots, F$. Each firm f, owns n^f oil concessions that are indexed by $i = 1, \ldots, n^f$. A concession is an agreement with a government that grants a firm the right to extract oil and gas in a geographic area as well as ownership over the extracted resources - in exchange for a variety of

[1]To determine the impact of wedges on output or welfare, we would also need to specify the consumer side of the model.

tax payments.[2] We assume that all concessions are operational and all fixed startup or exploration costs have already been paid. Furthermore, we exclude the possibility of entry or exit of new firms into the market or the entry of existing firms into new concessions. We do this to abstract from the investment process of exploring and developing new concessions and instead we focus on ongoing production. Thus, like Hsieh and Klenow (2009), we are interested in the intensive margin of production.

We assume that production takes place at the concession level, and a firm is a grouping of at least one concession. Each concession i held by firm f is characterized by the following production function:

$$(1) \qquad Y_i^f = B_i^f (K_i^f)^{\gamma_i} (L_i^f)^{\alpha_i}$$

Here Y_i^f is the output of oil produced by firm f at concession i whilst B_i^f is the exogenous productivity that captures firm-, concession- and country-specific effects. L_i^f and K_i^f are the labor and capital employed by firm f at concession i. We assume that labor and capital elasticities - α_i and γ_i respectively - are concession specific. In the tradition of span-of-control models, we also assume that our production function exhibits decreasing returns to scale with respect to labor and capital so that $\alpha_i, \gamma_i \in (0,1)$ and $0 < \alpha_i + \gamma_i < 1$. Decreasing returns to scale here capture the existence fixed assets (such as oil reserves) or of managerial ability that is required to operate each concession. The decreasing returns also mean that each concession makes a positive profit which can be thought of as rents arising from the existence of oil reserves or as compensation for a manager's or firm's know-how.

A firm's objective is to maximize total profits from all its concessions. Firms sell each unit of output for a price P and pay labor a wage rate w and capital a rental rate r. Each concession may also face a number of distortions or wedges. Distortions can be specific to each of the two factors of production, labor (τ_{Li}^f) and capital (τ_{Ki}^f), as well as common to both labor and capital, modelled as a distortion to revenues (τ_{Vi}^f). Each firm solves the following problem taking all prices as given:

$$(2) \qquad \pi_i^f = \max_{L_i^f, K_i^f} \sum_{i=1}^{n^f} P(1-\tau_{Vi}^f)Y_i^f - w(1+\tau_{Li}^f)L_i - r(1+\tau_{Ki}^f)K_i^f.$$

The price of oil, the wage rates and the rental rates are assumed to be the same

[2] Later, in our data, the geographic coverage of each concession almost always coincides with an entire country - with the exception of the United States and Canada - where concession data is aggregated at the state level.

across concessions in the model. This assumption stems from the fact that oil is a traded good whilst capital and labor inputs are very mobile within the oil industry.[3] Importantly, this assumption is only made with respect to pre-wedge prices. Any immobility of inputs or outputs will be be captured by the corresponding wedges.

Distortions From the first order conditions of this profit maximization problem we can determine the before-tax marginal revenue product of labor and capital:

$$(3) \qquad MRPL^{BT}_{f,i} \equiv P\frac{\partial Y^f_i}{\partial L^f_i} = \frac{(1+\tau^f_{Li})}{(1-\tau^f_{Vi})}w \quad \text{and} \quad MRPK^{BT}_{f,i} \equiv P\frac{\partial Y^f_i}{\partial K^f_i} = \frac{(1+\tau^f_{Ki})}{(1-\tau^f_{Vi})}r.$$

In order to maximize profits, firms will set the marginal revenues obtained from employing an additional unit of each factor (i.e. the left hand sides of the above expressions) equal to the marginal cost of that factor at each concession (i.e. the right hand side of the above expressions). Without distortions to labor, capital and/or revenues, the marginal costs of labor and capital faced by each concession is the same (w and r respectively). In this case, by equating marginal revenues of each concession to a common marginal cost, firms will effectively be equating marginal revenue products *across* concessions as well. This in turn implies that there will be no way to reassign capital or labor across concessions so as to increase aggregate output and hence there will be no misallocation of factors across concessions. On the other hand, if there are distortions to labor, capital and/or revenues, marginal costs will vary across concessions. Firms wishing to maximize profits will no longer equalize marginal revenue products across concessions. This in turn implies that aggregate output could be increased by moving factors from low MRP concessions to high MRP concessions. Consequently, examining the extent of the dispersion of MRP of each input will allows us to infer the extent of misallocation in the oil sector.

The goal of this paper is to quantify the extent to which direct revenue taxation can account for this dispersion. To this end, we define after-tax marginal revenue product of labor and capital:

$$(4) \quad MRPL^{AT}_{f,i} \equiv P(1-\tau^f_{Vi})\frac{\partial Y^f_i}{\partial L^f_i} = (1+\tau^f_{Li})w \quad \& \quad MRPK^{AT}_{f,i} \equiv P(1-\tau^f_{Vi})\frac{\partial Y^f_i}{\partial K^f_i} = (1+\tau^f_{Ki})r$$

[3] With the exception of a small share of low-skilled workers, labor and capital are shipped around the world. "Many work as so-called FIFOs, who 'Fly In and Fly Out' for their jobs, often on 7-7-7 rosters of seven days on, seven nights on, before flying home for seven days off" (The Telegraph , 2011). Capital is also mobile with rigs routinely dissembled and shipped around the world.

By comparing the dispersion of before- and after-tax MRPs of each factor, we will be able to determine the extent to which revenue taxation accounts for the dispersion of before-tax MRPs and hence the misallocation of labor and capital across concessions. To operationalize the above, we rearrange (3) and (4) and take logs to get:

$$(5) \quad \log\left(\frac{1+\tau^f_{Li}}{1-\tau^f_{Vi}}\right) = \log(\alpha^i) - \log(\lambda^{BT}_{f,i}) \quad \& \quad \log\left(\frac{1+\tau^f_{Ki}}{1-\tau^f_{Vi}}\right) = \log(\gamma^i) - \log(\kappa^{BT}_{f,i})$$

and

$$(6) \quad \log(1+\tau^f_{Li}) = \log(\alpha^i) - \log(\lambda^{AT}_{f,i}) \quad \& \quad \log(1+\tau^f_{Ki}) = \log(\gamma^i) - \log(\kappa^{AT}_{f,i}),$$

where, $\lambda^{BT}_{f,i} \equiv \frac{wL^f_i}{PY^f_i}$, $\kappa^{BT}_{f,i} \equiv \frac{rK^f_i}{PY^f_i}$, $\lambda^{AT}_{f,i} \equiv \frac{wL^f_i}{P(1-\tau^f_{Vi})Y^f_i}$ and $\kappa^{AT}_{f,i} \equiv \frac{rK^f_i}{P(1-\tau^f_{Vi})Y^f_i}$ are the before and after-tax labor and capital shares. Since wages and rental rates are common across concessions, examining the variation in before- and after-tax distortions will be equivalent to examining the variation of MRPs. In the next section we discuss the data that will allow us to extract the size of before- and after-tax distortions to labor and capital at the concession level using equations (5) and (6).

3 Data

Our data contains information on the 24 biggest private and public oil and gas firms. The selection of firms is based on Ross (2012), who constructed the list based on the stock value and the value of the resources owned by the firms.[4] For each of these firms we observe a number of financial variables reflecting their activities across countries between 1980 and 2013. The data is collected by Wood Mackenzie - a prominent consultancy in energy and mining industries - and is gathered in a variety of ways. First, they conduct face-to-face interviews with representatives from energy firms in the relevant countries and examine official financial reports of these firms. Second, they collect information provided by country-specific regulatory authorities and, third, they use a variety of media sources.

[4]Three firms were not included due to data limitations: the national oil companies of Iraq and Libya, and Surgutneftegaz which is a Russian hybrid (partly private and partly public). Since all of these companies are state owned and do not operate outside their own state we do not consider this to be a significant limitation for our purposes.

variable	**mean**	**p50**	**sd**	**max**	**min**
Total Revenue(mil. US$)	4768.11	760.80	19964.47	436419.10	1.80
Capital Cost (mil. US$)	508.02	91.20	1532.29	19756.90	0.10
Operational Cost (mil. US$)	586.43	108.00	2381.40	45709.20	0.10
Total Government Take (mil. US$)	2731.44	329.30	15143.22	364597.5	0.00
Total Government Take/Revenue	0.43	0.41	0.18	0.93	0.00

Table 1: Summary statistics

Concession The exploration of a new geographical area is always preceded by the creation of an agreement between the firm and the country hosting the firm. If the firm is granted 100% ownership of the product extracted, the agreement is referred to as a *concession*.[5] The negotiation and the allocation of concessions greatly varies across countries and depends on the existing petroleum laws and regulations (Venables, 2016). The total amount and the structure of payments received by governments under a concession are typically referred to as a petroleum fiscal regime. In some countries, a single fiscal regime applies to the entire country; in others, a variety of firm-specific regimes exist. In many cases, the concessions allocated to the same firm within the same country are also interlinked in a variety of ways (see the Global Oil and Gas Tax Guide 2017 for examples). In short, the exact nature of a concession greatly varies across political jurisdictions. Since we are interested in capturing such differences, in what follows, we operate with variables on the country-firm level for all countries with the exception of the US, where we operate on the state level for reasons which will become apparent, and we refer to repeated country-firm observations as a concession. In the last row of Table 1 we provide information on the realized concessions of all firms and time periods in our sample.

Descriptives Total Revenue is calculated as the quantity produced in barrels of oil-equivalent multiplied by the current price per barrel in US$ and is defined as PY_i^f for firm f in concession i. Capital Costs are calculated as the amount spent on durable goods (assets with lifetime > 1 year) in US$ and are defined as rK_i^f. Operational Costs are calculated as the amount spent on labor and non-durable goods e.g. (mostly)

[5]We focus only on concessions because it allows us to calculate the revenues generated by firms across countries. Agreements are referred to as *service contracts* if the firm is granted 0% ownership and as *production sharing agreements* if the firm is granted between 0 and 100% ownership. Such agreements imply that at least a share of the generated revenues by the firm is owned by the government of the country in which the firm is operating.

salaries and wages but also materials, insurance and maintenance in US$ and are defined as $w_t L_{it}^f$. Throughout the paper we will refer to this variable as labor costs.

Our main variable of interest is the Total Government Take (TGT) which is the total amount of tax payments received by the government from firms in exchange for exclusive rights to explore and extract oil and gas in a geographically defined area. As discussed above, the TGT is determined by the petroleum fiscal regime and encompasses a variety of flows, such as bonuses, rentals, royalties, corporate income taxes, profit taxes and a number of special taxes. While the TGT is considered to be the most common statistic for the evaluation of petroleum regimes it has disadvantages, as any other measure (Johnston, 2007; Venables, 2016). In particular, the TGT does not capture differences in the timing of payments, it does not capture adequately the risk associated with individual investments and it does not capture the ownership structure and the existence of non-pecuniary benefits (Johnston, 2007). However, due to the static nature of our analysis and our focus on concessions rather than more complex ownership structures involving non-pecuniary benefits, our results are robust to such criticism. Importantly, throughout our analysis we will treat TGT as a revenue tax which is defined as $\tau_{Vi}^f PY_i^f$. Whilst this is a simplification, historically governments have overwhelmingly chosen revenue taxes in order to overcome asymmetric information problems associated with observing costs in exploration and extraction (Mintz and Chen, 2012).[6]

Since we focus on the period of production rather than the initial investment, we restrict our sample to observations in which production, capital and operational expenditure are non-zero and we exclude observations in which the firm is running losses. Due to our level of aggregation these are essentially only observations in which the firm enters a new jurisdiction and needs to invest for a significant period of time before production starts. This leaves us with 3381 observations of 214 country-firm-concession combinations consisting of 24 firms, 41 countries and on average 26 years. The US and Canada lead the list with the largest number of concessions which is 46 and 22, respectively. The so-called 7 sisters have the largest number of concessions ranging form 14-28.[7]

[6] More recently, countries have slowly started moving towards a fiscal regime relying on profit based taxation (see Mintz and Chen (2012) for an excellent survey and discussion). Ideally, we thus would differentiate between revenue and other forms of taxation, however our data does allow for that. As a robustness check we reproduce our main results excluding all countries with profit based taxation as defined in the Global Oil and Gas Tax Guide 2017. Our results are not significantly affected and are available on request.

[7] Shell (28), ExxonMobile (26), Chevron (26), BP (23), ConocoPhilips (22), Total (19) and ENI (14).

4 Empirics

Estimation To extract wedges from equations (5) and (6) we need estimates of $\lambda_{f,i}^{BT}$, $\kappa_{f,i}^{BT}$, $\lambda_{f,i}^{AT}$, $\kappa_{f,i}^{AT}$, $\log(\alpha^i)$ and $\log(\gamma^i)$. Whilst we do observe the before and after-tax capital and labor shares directly using the data described in the previous section, we do not observe the values of $\log(\alpha^i)$ and $\log(\gamma^i)$. To overcome the latter we proceed as follows. First, we assume the average log-labor and log-capital wedge in the US to be zero following Hsieh and Klenow (2009).[8] Since we report all our results relative to the US, this assumption is effectively a normalization. Second, we assume that due to its geographic size, the US exhibits large geological variation, which allows us to consistently estimate the population means of $\log(\alpha^i)$ and $\log(\gamma^i)$ and mimic the respective population means in the rest of the world.[9] This is supported by evidence presented in Table 2 which compares the availability of hydrocarbons in the US to the rest of the world (ROW). The first two rows compare the average number of giant oil discoveries and their cumulative size per square mile since 1900 in both regions, whilst the last row compares the estimated oil reserves per square mile in 2005. In column (3) we show that these differences are not statistically significant. Thus, taking advantage of the state level US data we can estimate the mean log-elasticities, $\mathbb{E}\left(\log(\alpha^i)\right) = \overline{\log(\alpha)}_{US}$ and $\mathbb{E}\left(\log(\gamma^i)\right) = \overline{\log(\gamma)}_{US}$, which are -1.38 and -1.57, respectively. Given these estimates we can take the expected value of equations (5) and (6) and obtain a *best-guess* estimate for wedges at the concession-level:

$$(7)\quad \mathbb{E}\left[\log\left(\frac{1+\tau_{Li}^{f}}{1-\tau_{Vi}^{f}}\right)\right] = \overline{\log(\alpha)}_{US} - \log(\lambda_{f,i}^{BT}) \& \ \mathbb{E}\left[\log\left(\frac{1+\tau_{Ki}^{f}}{1-\tau_{Vi}^{f}}\right)\right] = \overline{\log(\gamma)}_{US} - \log(\kappa_{f,i}^{BT}),$$

$$(8)\quad \mathbb{E}\left[\log(1+\tau_{Li}^{f})\right] = \overline{\log(\alpha)}_{US} - \log(\lambda_{f,i}^{AT}) \quad \& \quad \mathbb{E}\left[\log(1+\tau_{Ki}^{f})\right] = \overline{\log(\gamma)}_{US} - \log(\kappa_{f,i}^{AT}).$$

Baseline Results To analyze our results, we begin by comparing the averages of our best-guess wedges in the ROW to our US benchmark (see Table 3).[10] The average, before-tax wedges in both regions are presented in the first column of rows (1) and (3). In the US, the average, before-tax wedges are 0.44 for both labor and capital.

[8] In other words we set, $\overline{\log(1+\tau_{Li}^{f})}_{US} \approx \overline{\tau_{LiUS}^{f}} = 0$ and $\overline{\log(1+\tau_{Ki}^{f})}_{US} \approx \overline{\tau_{KiUS}^{f}} = 0$.

[9] Note that a sufficient, albeit not necessary condition, would be to assume that due to the geographical size of the US, representing a significant share of the global landmass, the respective distributions of hydrocarbons between the US and ROW do not differ significantly.

[10] We obtain very similar results when examining medians instead of means.

Geology Measures	US (1)	ROW (2)	Diff. (3)	p-value (4)
Number of large discoveries per m^2 since 1900	-11.44	-11.28	0.16	0.42
Total size of large discoveries per m^2 since 1900	-4.34	-4.20	0.14	0.58
Estimated oil reserves per m^2 in 2005	7.77	7.62	0.15	0.68

Data on large discoveries is from Horn (2011). Data on estimated reserves is from Nationmaster. Column (3) shows the p-value of an equality test of the means in the respective groups.

Table 2: Logged averages in the US versus the rest of the world (ROW)

In the ROW, the average, before-tax wedges are 0.67 for labor and 0.77 for capital. Columns (3) - (4) indicate that these differences are not only economically (26% higher for labor and 38% higher for capital in ROW) but also statistically significant. These large differences, however, vanish entirely once we account for variation in direct revenue taxation across concessions. The first column of row (2) and (4) shows the average, after-tax wedges in both regions. Since the US serves as our benchmark, by construction, the average, after-tax wedge for labor and capital in the US is zero. Our main results, shown in column (3) and (4), indicate that the after-tax wedges in the ROW are economically similar and statistically *not* different from the after-tax wedges in the US.

Distributional Results Next, in Figure 1 we compare the distributions of our best-guess capital and labor wedges in the ROW relative to the US, before and after accounting for taxation.[11] Consistent with our previous results, the distribution of wedges in ROW is shifted to the right relative to our distribution of wedges in the US. Not surprisingly, we overwhelmingly reject the null hypothesis of distributional equality. However, once we account for revenue taxation, both distributions are centred around 0 and we can no longer reject the null hypothesis of distributional equality between the ROW and the US at the 5% level.

Firm-level Results Figure 2 depticts our results disaggregated by firms. The black dots represent average before-tax wedges of each firm, whilst the blue dots represent

[11]We observe a positive variance in the distribution of after-tax wedges in the US. This indicates that *after-tax* marginal revenue products in the US are not equalized across concessions. Hsieh and Klenow (2009) find similar results for US manufacturing firms and argue that this type of variation is potentially indicative of measurement error or model misspecification. In our case this variance within the US could also be driven by the variation in US geology. In either case, this highlights the importance of comparing distortions to some baseline in order to account for common sources of variation.

Labor	US	ROW	Diff.	p-value
	(1)	(2)	(3)	(4)
(1) Mean - before Taxes	0.44	0.67	0.23	0.00
(2) Mean - after Taxes	**0.00**	-0.01	**0.01**	**0.73**
Capital	US	ROW	Diff	p-value
	(1)	(2)	(3)	(4)
(3) Mean - before Taxes	0.44	0.77	0.33	0.00
(4) Mean - after Taxes	**0.00**	0.08	**0.08**	**0.26**

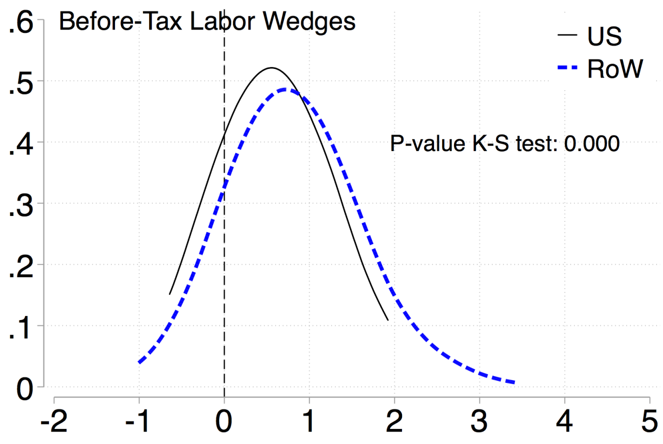
Note: In column (4) the p-value of an equality test of the means in the respective groups is presented. We account for the correlation of observations on the country level (41 clusters).

Table 3: Mean Wedges

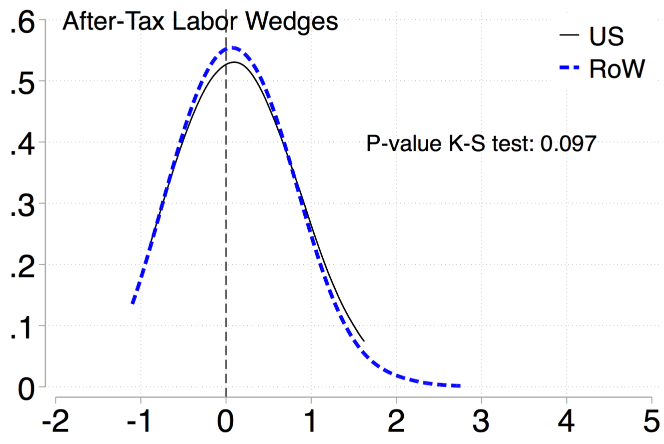
average after-tax wedges of each firm. We divide our analysis into private and public firms. We find that accounting for direct taxation almost completely eliminates the observed wedges in case of private firms (columns (1) and (2)). For public companies, on the other hand, whilst accounting for taxes significantly reduces the size of distortions, it does not - in general - lead to an elimination of all the wedges. This either indicates remaining inefficiencies in public sector firms or a distorted measure of taxation. Most importantly, Figure 2 implies that our main results are driven by the activity of private firms.

5 Conclusion

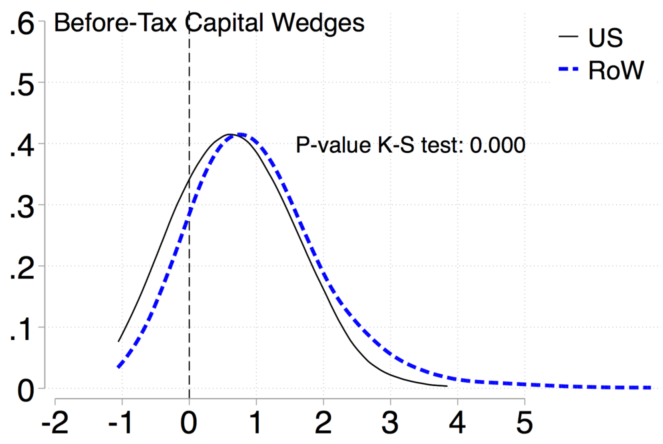
We use a new data set of the oil and gas sector to confirm the existence of sizeable gaps in marginal revenue products across countries. We show that these disappear once we account for direct revenue taxes - a result driven primarily by private rather than public firms. We conclude that tax policies are a sufficient statistic to explain the variation in wedges extracted using the Hsieh and Klenow (2009) methodology. If wedges are caused by differences in taxation, harmonizing taxes across countries would eliminate differences in MRPs and productivity. However, equilibrium tax rates may themselves be functions of wedges such as trade costs, geography and the quality of institutions. In light of the above results, the obvious next step to understand the misallocation of capital and labor across countries will be the exploration of how taxes are agreed upon during negotiations between firms and countries.



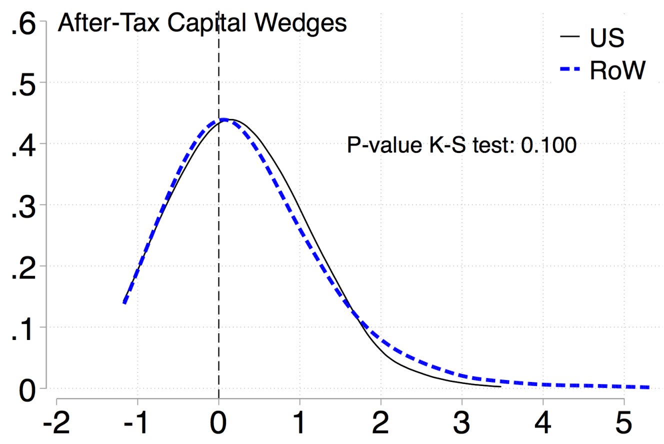
(a) Labor Wedges - before taxes



(b) Labor Wedges - after taxes



(c) Capital Wedges - before taxes



(d) Capital Wedges - after taxes

Figure 1: Wedges in Labor and Capital

Note: P-value K-S test indicates the results of the Kolmogorov-Smirnov test comparing the distributions of best-guess wedges in the US versus the rest of the world (ROW).

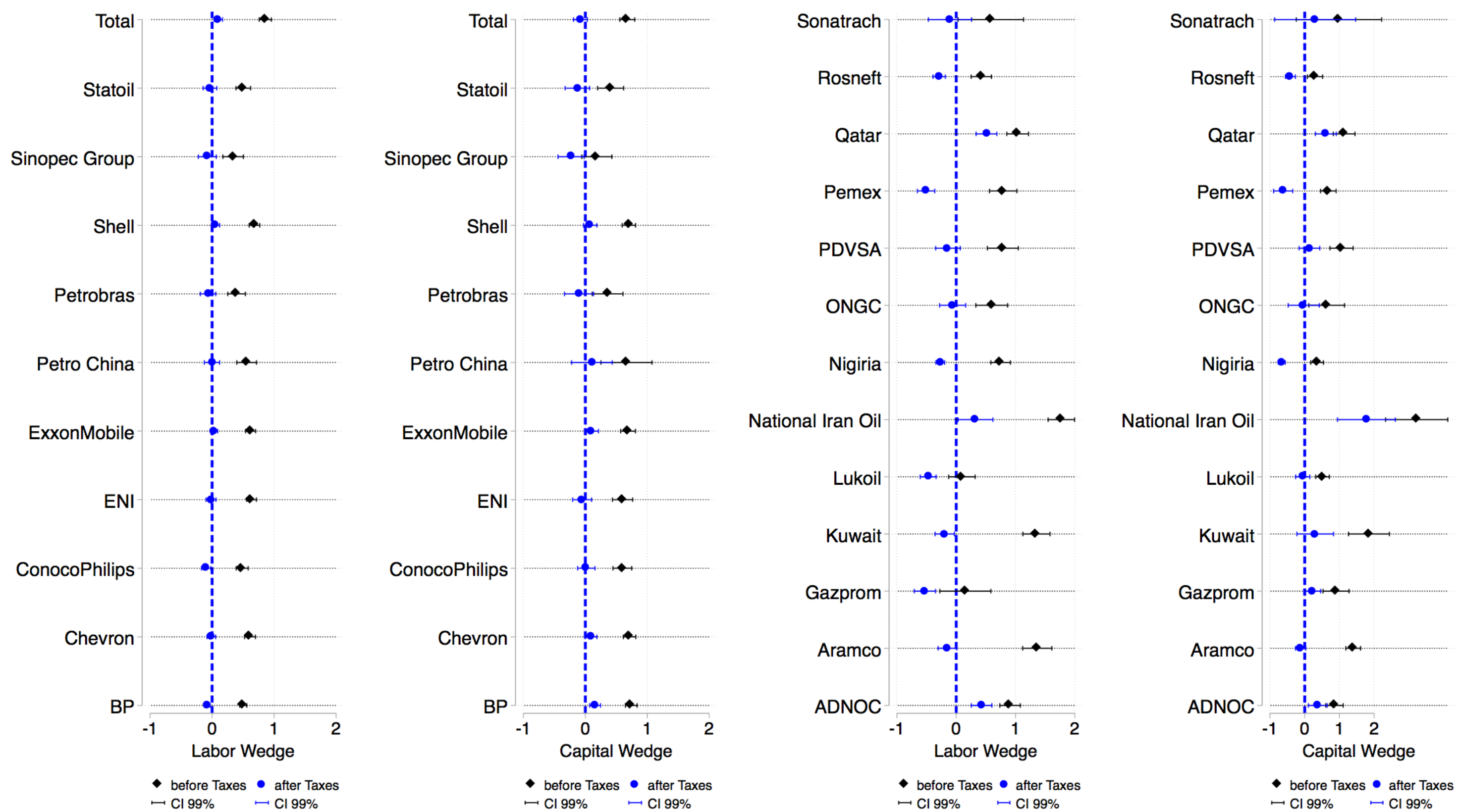


Figure 2: Wedges in Private (Column (1) and (2)) and Public Firms (Column (3) and (4))

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