Discussion Paper No. 13-014

The Effects of Public Spending Composition on Firm Productivity

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Non-Technical Summary

Good policy advice, in addition to requiring sound theoretical frameworks to identify growth-enhancing fiscal reforms, also needs a reliable evidence base. Much of this evidence base has traditionally come from applications of econometric methods to various fiscal aggregates. However, concerns have recently been raised over the merits of this type of evidence for policy reform advice in practice; see, for example, Rodrik (2005), Hausmann et al. (2008a). It seems therefore useful to question whether business perception data included for instance in the World Bank Enterprise Surveys (WBES) are a useful additional source of information to guide policy makers' choices. These surveys contain ratings of various factors regarded as 'obstacles' or 'constraints' on firms' growth performance as identified by firm owners or managers. With firms' investment decisions likely to be an important driver of aggregate economic growth, and these investment decisions likely to be affected by firms' perceptions, such perception indicators could potentially be a valuable source of information on actual growth constraints. Indeed, a number of authors have recently argued over the merits of such business survey information as a reliable identifier of actual constraints, and the policy reforms that might follow.

The objective of this paper is to examine whether, and when, subjective perceptions of firms may be a useful source of information to help identify growth-enhancing fiscal reforms. Specifically, adopting the standard theoretical framework for the analysis of fiscal policy and long-run growth, we demonstrate that firms' perceptions can be expected to suffer from particular biases. We show that while these biases can be expected to be important for some fiscal policy reform options, they are not for others. This suggests that it is important to distinguish between the specific contexts in which such business perception information is likely to offer reliable or unreliable guidance to growth-enhancing policy reforms. The essence of our argument is that, in part because of the way business survey questions are constructed, firms' responses can be expected to focus on the direct effects of policies alleviating particular constraints that they see as obstacles, while ignoring the externalities, or indirect effects of these policies. We exploit this assumption to model firm perceptions of fiscal policy-related constraints including taxation and public expenditures taking two different forms: flows of public services and stocks of public capital.

The paper makes two contributions. The first is to evaluate, based on a class of endogenous growth models, whether business perception data could be useful in identifying the optimal direction for fiscal policy reform. We show that, regardless of model parameters, it is likely that firms perceive the (distortionary) tax rate as a more severe constraint than public service-related constraints, which in turn are likely to be perceived as more severe than public capital-related constraints. Firms view fiscal constraints in this order even when taxes and spending are set at their optimal, growth-maximizing values (i.e. where changes to any fiscal parameters would result in declines of the growth rate). However, this framework also predicts that for comparisons of fiscal constraints involving similar types of public spending (e.g. between two public service-related, or two public capital-related, spending categories), business perception data do not suffer from such systematic biases vis-à-vis optimal policy responses.

The second contribution is to compare actual business perception data from the World Bank Enterprise Surveys, and in particular how firms rank fiscal policy-related constraints, with the ranking predicted by the endogenous fiscal-growth framework. We find that the WBES rankings of fiscal policy-related constraints closely match those predicted by the theoretical models.

Das Wichtigste in Kürze

Politikempfehlungen zur Förderung von Wirtschaftswachstum basieren idealerweise auf theoretischen Modellen und auf empirischer Evidenz. Letztere ist traditionell das Ergebnis statistischer Auswertungen von aggregierten fiskalpolitischen Daten mittels Regressionen. In der Literatur werden Politikempfehlungen, die auf dieser Art von empirischer Evidenz basieren, allerdings zunehmend kritisiert, siehe z.B. Rodrik (2005) und Hausmann et al. (2008a). Daher ist es wichtig zu evaluieren, ob Perzeptionen von Unternehmen, die beispielsweise im Rahmen von den Weltbank Enterprise Surveys (WBES) erhoben werden, möglicherweise eine zusätzliche Informationsquelle für fiskalpolitische Entscheidungen von Regierungen darstellen. In diesen Befragungen bewerten Eigentümern bzw. Manager verschiedene Faktoren, die möglicherweise die Performance von Unternehmen beeinträchtigen. Da Investitionsentscheidungen von Unternehmen zentral für makroökonomisches Wachstum sind und möglicherweise von den Perzeptionen der Unternehmen beeinflusst werden, sind perzeptions-basierte Indikatoren potentiell eine wichtige Informationsquelle für tatsächliche Wachstumshindernisse. Mehrere Studien haben in jüngster Vergangenheit den Wert von Unternehmensperzeptionen für wirtschaftspolitische Reformen untersucht.

Das Ziel dieser Studie besteht darin zu bewerten, ob und wann subjektive Perzeptionen von Unternehmen helfen können, spezifische wachstumsfördernde fiskalpolitische Reformen zu identifizieren. Mit Hilfe eines oft benutzten theoretischen Modells für die Analyse von Fiskalpolitik und langfristigem Wachstum zeigen wir, dass Unternehmensperzeptionen verzerrt sind. Diese Verzerrungen spielen eine große Rolle bei der Bewertung einiger, aber nicht aller, fiskalpolitischer Reformoptionen. Dies impliziert, dass es wichtig ist, Fälle, in denen Unternehmensperzeptionen eine verlässliche Informationsquelle darstellen, von anderen Fällen zu unterscheiden. Der Kern unseres Arguments besteht darin, dass Unternehmen vor allem die direkten Effekte bewerten, die aus der Beseitigung bestimmter wachstumshemmender Faktoren entstehen, aber gleichzeitig auftretende Externalitäten weitgehend ignorieren. Diese Modellannahme benutzen wir, um Unternehmensperzeptionen von mit Fiskalpolitik in Verbindung stehenden Wachstumshemmnissen modelltheoretisch abzubilden. Wir untersuchen Steuern, öffentliche Dienstleistungen und den öffentlichen Kapitalstock in unserem Modell.

Diese Studie zeigt erstens, dass Unternehmen unabhängig von Modellparametern verzerrende Steuern als das größte Wachstumshindernis sehen. Öffentliche Dienstleistungen werden von Unternehmen meist als größeres Wachstumshindernis gesehen als Wachstumshindernisse, die mit dem öffentlichen Kapitalstock zusammenhängen. Diese Reihenfolge in der Bewertung von Wachstumshindernissen ergibt sich auch, wenn die Höhe von Steuern und Ausgaben optimal, d.h. wachstumsmaximierend, ist. Gleichzeitig zeigen wir jedoch, dass Unternehmen die relative Wichtigkeit von gleichartigen Wachstumshindernissen (z.B. unterschiedliche Arten von öffentlichen Dienstleistungen) korrekt einschätzen können. Schließlich vergleichen wir die WBES-Daten mit den Vorhersagen unseres Modells. Wir zeigen, dass die beobachteten WBES-Rankings mit unserem Modell konsistent sind.

The Effects of Public Spending Composition on Firm Productivity*

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Abstract

This paper exploits the unique institutional features of South Africa to estimate the impact of provincial public spending on health, education and transport on firm productivity. Our identification strategy is based on within industry-province differences between firms of the effects of public spending. We show that public spending composition affects firm productivity depending on the capital intensity of firms relative to the province-industry mean. Our data and empirical specification allow us to rule out that these results are affected by econometric problems that are commonly encountered when estimating the effects of fiscal policy and by unobserved industry- or province-specific productivity shocks. In contrast to related existing microeconomic evidence, we take into account the government budget constraint so that our results have clear policy implications.

JEL code: D24, H32, H72, O12

Keywords: Public Spending Composition, Productive Public Spending, Firm Productivity

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1 Introduction

It has long been understood within theories of economic growth and development that changes to fiscal policy, including changes in the composition of public spending, affect aggregate outcomes such as the rate of economic growth (Barro, 1990, Devarajan et al. 1996). Increasingly, cross-country empirical evidence has been found to support these model predictions. For instance, Adam and Bevan (2005), Lopéz and Miller (2007), and Hong and Ahmed (2009) find that greater productive expenditures, usually defined as including spending on transport, communication, education, and health, have significant, positive growth effects. The consistency of these findings suggests that these findings are robust, but because they are generated using macro data they are open to the criticisms that the exact transmission mechanisms through which public spending are effective are left unclear, and that they are likely to mask variation in the effects of fiscal policy on different firms (Schwellnus and Arnold, 2008).

In this paper, using data for South African firms, we investigate differences in the effects of changes in the mix of public spending on firm level productivity. There are various channels through which education, health and transport expenditure may affect private sector productivity. In growth models with public finance, public expenditure affects growth mainly through its effects on the marginal product of factor inputs including labor and capital. For instance, private equipment such as machinery and vehicles can be employed more productively when public infrastructure is in place, and people with access to basic health care can work more productively; see for instance Agénor (2008a,b) who summarizes relevant empirical evidence to motivate an endogenous growth model with public finance that incorporates public spending in these areas. As aggregate growth outcomes must ultimately be the result of changes to productivity that occur at the firm level, firm-level data can provide evidence for a specific channel through which aggregate growth outcomes could occur. More importantly, because aggregate policy changes are unlikely to be determined by the individual firm, our approach deals more convincingly with any simultaneity bias complementing

those results of the macro literature.

To conduct the analysis we exploit the particular fiscal context in South Africa, and in particular the institutional mismatch between revenue-raising and spending powers at the provincial level. This has the advantage that it allows us to control for the government budget constraint in our estimations, an issue shown to have a strong effect on results in macro growth regressions (Kneller et al., 1999). All broad based taxes are identical across South African provinces and borrowing at the sub-national level is limited. As a result, the level of public spending is largely exogenous to the individual province and dependent on grants from the central government. Discretionary fiscal policy choices instead differ across provinces and time in South Africa in terms of the chosen mix of expenditures. Our empirical specification therefore focuses on the effects of changes to the mix of public spending and separates them from effects of changes in the level of spending. The fiscal data also include details on public spending beyond those usually available, including various types of health, education and transport expenditures by province. This allows us to both exclude components of these expenditures, such as those on administration, where the productivity-enhancing effects for firms are less obvious, but also to broaden the analysis of fiscal policy effects on firm performance compared to previous studies that mostly focus on changes in transport infrastructure.[1] As an additional advantage, public spending data from South Africa is of high quality compared to other countries which we discuss in greater detail below.

That the effects of taxation can be separated from those of expenditures on South African firms in addition to the use of micro data does not in itself indicate that the correlations we uncover are causal of course. An important

[1] See for instance Datta, 2012; Shirley and Winston, 2004; and Reinikka and Svensson, 2002. The papers that are closest to ours are Bekes and Murakozy (2005) and Gabe (2003). The former uses data from Hungary and finds that public investment by the central government has positive and significant effects on firm productivity, and that public investment by municipalities has negative and significant effects. Two potential problems with their estimation are that municipalities are rather small so that public investment may entail significant spillovers which they do not control for and that they do not take into account the government budget constraint. Gabe (2003) uses expenditure and revenue variables to explain firm growth (measured as the change of employment) in the U.S. and does not find large and/or significant effects of fiscal policy.

consideration here must be whether fiscal expenditures are targeted at particular industries in particular provinces because they have lower or higher productivity than elsewhere. Or it could occur that unobserved province-specific factors, such as unobserved economic shocks, affect the productivity of firms within an province and, through the automatic stabilizer mechanism, may generate a change to the mix of expenditures. To deal with the omission of difficult to observe economic shocks to provinces and industries we include full set of province-year and industry-year dummies in all our regressions. To control for time-invariant omitted province-industry specific factors such as geography or climate that may determine the mix of expenditures and affect the productivity of firms we also include in all specifications a full set of province-industry dummies. This set of dummy variables rules out province-time, industry-time and province-industry omitted variables as possible explanations for our results. However, these factors do not control for economic shocks that are province-industry specific, or for national policies that are aimed at industries in particular provinces. To control for this possibility we also test the robustness of our findings to the inclusion of province-industry-time dummies.

In these regressions, to identify the productivity-enhancing effects of public spending we exploit differences in these effects between firms that are located within the same industry and province which we show are driven by their capital-labor ratios. That the capital-labor ratio is critical for the effects of public spending on productivity can be directly derived from the type of transmission channels discussed above. For instance, labor-intensive firms can be expected to be more susceptible for basic health spending, and spending on public transport. The reason is that these spending categories primarily affect labor productivity. To correct for any province-specific industry effects that may cause the average capital-labor ratio to vary systematically across provinces and industries, where this may include the composition of public expenditures, the capital-labor ratio of the firm is measured relative to the mean in each individual industry, province and time period. This implies that we are comparing across firms that operate within the same province and industry but have chosen to use different combinations of capital and

labor. If, as seems plausible, these differences in the capital-labor ratio are exogenous to any common province-industry economic shocks, then these differences can be exploited to identify the effect of changes in the expenditure mix on firm performance. As another advantage of using the capital intensity as a way to identify the effects of public spending, we automatically control for any independent effects that capital and labor may have, given that we estimate a production function with capital and labor as independent variables. The presentation of this identification strategy is our first contribution.

Our second contribution is to apply this type of identification to our data. Given the categories of public spending that we label as productive, we anticipate that these effects are stronger for firms that use labor relatively more intensively, i.e., those with relatively low capital-labor ratios. The disadvantage of our approach is that we cannot identify the overall magnitude of the effect of fiscal policy on firm performance as any direct effects of fiscal policy on productivity are captured by the province and industry dummies we include. The question we answer is therefore narrower than the cross-country correlations between fiscal policy and growth that motivate this study.

To preview our results, we find that reallocating public resources towards productive categories (defined as subcomponents of expenditures on education, health, and transport) has a robust, positive and significant effect on the productivity of firms with capital-labor ratios in the bottom quartile of the distribution within their industry, province and year over the medium run. For those firms that use capital-to-labor with a greater intensity, we uncover less robust effects. The effects are always positive, but only occasionally significant. From this we conclude that there is evidence that those firms that choose to use relatively more labor than capital compared to others in their industry in that province and year benefit most from a change in the expenditure mix towards productive spending. These findings are robust to a number of well known biases that arise in the estimation of firm level production functions and to the inclusion of omitted factors at the firm, industry, province, or time period that may help to determine firm productivity. These robustness checks include the use of the Levinsohn-Petrin estimator and firm

fixed effects to address the endogeneity of factor inputs. These findings are also robust to a number of other potential concerns, for instance to the exact definition of productive expenditure that we choose.

The paper is organized as follows. Section 2 presents the data and descriptive statistics. Section 3 develops the modelling framework. Section 4 discusses the results, and Section 5 presents several robustness checks of the results. Section 6 concludes.

2 Data

2.1 The System of Fiscal Decentralization in South Africa

The features of fiscal decentralization in South Africa are central to our estimation strategy. Since the end of the Apartheid era, South Africa has undergone wide-ranging fiscal reforms, and a system of transparent, constitutionally compliant intergovernmental fiscal relations has been created. Government now comprises three spheres: national, provincial and local. The fiscal system departs from conventional prescripts of fiscal federalism however because there is a mismatch between expenditure and revenue powers at each of these different levels of government (Ajam and Aron, 2007).

Public expenditure policy is decentralized in a range of important areas. Provincial governments are largely responsible for spending on provincial roads, education (except higher education), health services, public transportation, social welfare services, housing and agriculture. For these functions, the level of public spending by the national government is very low, and the national government is mainly responsible for setting minimum norms and standards and for monitoring the overall implementation by provincial governments. It also collects data on provincial public spending (Momoniat, 2002). The expenditure that the national government undertakes can be expected to leave firm productivity unaffected over the medium run, or it finances public goods such as national roads or higher education and research. In these cases, significant country-wide spillovers imply that there is no or

little variation between the provinces. By contrast, provincial governments provide goods and services that are unlikely to entail significant spillovers across provinces.

At the same time, the revenue side of government in South Africa is fairly centralized: provincial governments collect very little revenue, and the income raised within the province typically amounts to less than 5% of the provincial budget (Ajam and Aron, 2007). In the period that we consider, provinces have neither imposed nor collected broad base taxes, and the revenue collected came from various licences (notably motor vehicle licences), sales of goods, services and capital assets and various small base taxes (e.g. taxes on gambling and horse racing). In addition, while in principle, provincial governments are allowed to borrow to finance capital expenditure, in practice borrowing is quite limited. Provincial governments are therefore highly dependent on transfers from the national government. They receive conditional grants which they have to earmark for pre-specified purposes, such as health, infrastructure, housing and social development, and they receive non-earmarked grants (which are referred to as 'equitable share grants') (Ajam and Aron, 2007). The level of the latter that a given province receives depends on range of social and economic indicators.

These features together with the high quality of public spending data which we discuss below make South Africa an interesting testing ground to empirically evaluate the productive effects of public spending. First, the system of fiscal decentralization implies that regional variation in the level of spending on central sectors is observable. Monitoring at the national level lowers differences in terms of public spending efficiency across provinces, and data collection at the national level is likely to imply that public spending categories are nearly identical. Second, given the government budget constraint, the effects of public spending depend on the financing mechanisms and are therefore intertwined with those of taxation. In South Africa, the fact that the national government levies most taxes which are identical across provinces while provincial governments are in charge of expenditure categories allows us to distinctly estimate the 'net' effects of public spending. This limits the degree of unobserved heterogeneity across provinces.

The effects of public spending we estimate will not contain the effect of their implicit financing through possibly productivity distorting forms of taxation of the type reported in Schwellnus and Arnold (2008). In the regressions any productivity effects from the tax system in South Africa will be captured by province-time effects.

In order to ensure that our results are relevant for policy, it is important to take into account which expenditure policy parameters provincial governments are able to set. Given that the level of total expenditure by the provinces is almost completely determined by grants from the national governments which are largely beyond the control of provincial governments, at least over the short- to medium run, it is the composition of public spending where the discretion and autonomy of provincial governments seems to be much more important. Any effect that the level of fiscal expenditures might have on the productivity of firms will again be captured by the province-time effects also included in the regression.

2.2 Firm level Data

The information on firms that we use is from the World Bank's Enterprise Surveys. These data are rich in detail on firm characteristics, and are designed to be representative of the population of firms. However, they contain, at least in comparison to other firm level datasets, a relatively small number of observations and a limited panel dimension. We use data from two rounds of the World Bank Enterprise Surveys in South Africa in 2002 and 2006, providing a total possible sample of 1,113 observations for use in our regressions. The use of questions within the survey that ask for information for earlier years means that while most control variables are only available for 2002 and 2006, information on firm output and most inputs is in principle available for four years (2000, 2001, 2002 and 2006). The panel is unbalanced with an average number of years per firm of approximately 1.95. We recognize that an implication of the limited time dimension of the data is that we are likely to identify productive effects from public spending that are relatively instantaneous and miss those that take longer to affect firm decisions. Finally, we

corrected the data for obvious keypunch errors, deleted observations with negative inputs or outputs and one observation with idiosyncratically high sales volatility.

The firms surveyed are located in four out of nine South African provinces and include Gauteng, Western Cape, Kwazulu-Natal and Eastern Cape (in descending order by the number of firms located in each province that are included in the surveys). Within each province considered, the majority of the firms are located in the biggest city (Johannesburg, Cape Town, Durban and Port Elizabeth). As most firms are located far away from other provinces, it seems unlikely that they benefit from spending from other provincial governments thereby minimizing problems related to estimating the effects of public spending in the presence of benefit spillovers.

At the firm level, we use total firm sales deflated by a sector-specific deflator as a proxy of firm output, the net book value of equipment and machines deflated by an economy-wide deflator as a proxy of private capital, the number of employees, and the cost of materials and intermediate goods which we likewise deflate using an economy-wide deflator. We further use information from the Enterprise Surveys to construct dummy variables for foreign firms, large firms, exporting firms and firms that experienced losses due to crime.[2] These represent other firm specific factors that might affect a firms' productivity. Tables 1 and 2 contain details about the firm level variables and descriptive statistics.

2.3 Public Spending Data

Given that the location of each firm is known, it is possible to merge our firm level data with provincial spending data provided by the South African Treasury. Our provincial dataset includes public spending that is disaggregated at the sub-sectoral level. In principle, our dataset also includes control variables that reflect the quality of education and road infrastructure in each province, but the effects of those variables are all captured by province-time effects.

[2] A reliable variable for the age of the firm is not available and cannot be included. Since it would be time-invariant, our empirical specifications with firm fixed effect capture the effects of firm age.

Table 1: Firm variables and provincial variables

Variable	**Description**	**Years**
sales (y)	total sales per firm (in logs)	2000, 2001, 2002, 2006
capital (k)	net book value of machinery, vehicles, and equipment (in logs)	2000, 2001, 2002, 2006
labor (l)	total workers (in logs)	2000, 2001, 2002, 2006
materials (m)	total cost of raw materials and intermediate goods (in logs)	2000, 2001, 2002, 2006
exporter	dummy (1 if firm sells goods in other countries)	2002, 2006
crime	dummy (1 if firm suffers losses due to theft, robbery, vandalism or arson)	2002, 2006
foreign	dummy (1 if foreign ownership $> 10\%$)	2002, 2006
large	dummy (1 if labor > 50)	2002, 2006

Table 2: Firm variables and provincial control variables

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
sales	11.825	2.273	4.038	19.531
capital	10.058	2.087	2.641	16.832
labor	4.025	1.626	0	9.928
materials	11.054	2.471	1.948	19.442
exporter	0.092	0.289	0	1
crime	0.463	0.499	0	1
foreign	0.507	0.5	0	1
large	0.671	0.47	0	1

The variable definitions can be found in Table 1.

While public spending data may often only poorly reflect public outputs in terms of public services delivered and public capital accumulated, anecdotal evidence suggests that public spending data from South Africa is relatively reliable and reaches the beneficiaries in most cases. Ajan and Aron (2007) note for instance that the quality of fiscal data, budget planning and control at all levels of government has been improved as part of the fiscal reforms. A report commissioned by Delegation of the European Union in South Africa also finds that the level of transparency in South Africa's budget processes is high (Quist et al., 2008). The Open Budget Survey ranks developing and developed countries based on their budget transparency and accountability. South Africa regularly ranks among the top five countries suggesting that abuse or inefficient use of public resources would be much easier to spot and is therefore more unlikely to occur.

Provinces spend, among other things, on education, health, road infrastructure and public transport. Following Kneller et al. (1999) and others we label these as productive spending (we do not consider spending by the national government which cannot be traced by geographical location and which can be assumed to have significant nation-wide spillovers given the types of public goods and services it provides or by municipalities where existing data are not sufficient). Our data also allow further disaggregation of these expenditure functions. Given that the time dimension of the firm-level data limits our ability to consider long lags of productive effects of public spending, we use this to exclude subcategories of education, health and public transport and capital expenditure that may be expected to affect firm productivity to a lesser extent or not at all over a period of around two years. Following convention, we label the remaining / excluded public spending categories as unproductive.[3] Table 3 provides an overview of how we categorize public spending. For instance, in the education and health sectors, we exclude administration spending. The remaining expenditure may plausibly affect firm productivity over the medium run.

Obviously, some parts of productive expenditure can only be expected to

[3]It is important to note however that public spending which is classified as unproductive is not necessarily wasteful and may enhance social welfare.

affect private sector productivity over the very long run, such as the construction of a new bridge or tunnel which takes years to complete but which may increase productivity of private vehicles by cutting travel time. Here, we focus on productive effects of public spending that are likely to materialize over a period of 1 to 2 years. Spending on public transport, traffic management and road maintenance are likely to deliver much more quickly tangible benefits. Spending on public health may also rapidly improve labor productivity, if for instance it results in increased availability of drugs against common diseases, or if public awareness to prevent accidents or certain types of diseases increases. Even spending on education may have almost immediate effects on productivity: for instance, as a result of education spending on early childhood development, labor productivity of the parents may improve fairly quickly. In addition, improved education of students shortly prior to graduation or spending on short courses for adults may affect labor productivity over the medium run. Nevertheless, we consider the robustness of the our results to these choices in Section 6.

We express the amount of productive public spending as the share of total public spending by province. Total public expenditure is the sum of productive and unproductive expenditure. Public spending data are available for all four provinces for the fiscal years 2000/2001 through to 2005/2006. Given that public spending may vary with business cycle fluctuations and that any effects on productivity may become apparent only after some lags, we follow to some extent the macroeconomic literature and take averages of public spending over two fiscal years. Specifically, we regress the firm information for 2002 with the average of the fiscal data for 2000/2001 and 2001/2002, and use the average of the 2004/2005 and 2005/2006 fiscal years for the 2006 firm data. The implication of this is that where our firm data are additionally available for 2000 and 2001 the public spending data are not. We trade this loss of information against reducing possible co-movement of the business cycle with productivity and government expenditure composition and against considering longer lags in the effects of public spending. Depending on the specification, we still use the 2000 and 2001 firm data for our estimation.

Table 4 provides descriptive statistics, and Figure 1 displays productive

spending and its subcomponents as shares of total provincial expenditure by province and year. Even with a relatively narrow definition of what constitutes productive spending, as a share of total province level spending, it is relatively high at 55 per cent. As the table makes clear, the variation in public spending categories also comes primarily from variation between provinces rather than within provinces across time. The standard deviation between provinces is around 3 times that within provinces. Cross-time changes in the expenditure mix is also evident though. The share of productive to unproductive spending increased in all provinces between 2002 and 2006 (where the 2002 and 2006 values are in fact both averages over two fiscal years as explained above) and the increases in Eastern Cape and KwaZulu-Natal were particularly large. The table also shows that most productive expenditures relate to those on education, which are around twice as large as those for health and over 7 times those on transport and capital expenditure. Figure 1 implies that the shares of productive spending increased in all four provinces over the period considered, but the relative increase varied and ranges from around 17% in Western Cape to around 25% in Eastern Cape.

3 Modelling Framework

As is typical in the literature we assume that output, Y_{it}, of firm i in year t, is produced using private capital (K_{it}), labor (L_{it}), and materials (M_{it}). Into this framework we incorporate as an additional variable a composite public input that represents the level of public services and public capital and that enhances firm productivity, G_{tp}, which varies across time and provinces, where p denotes the province. As production technology, we use the type of CES production function originally proposed by David and van de Klundert (1965) which allows for the effects of G_{pt} to be *not* Hicks-neutral:

$$Y_{it} = A\left[\left(\beta_1 \epsilon_{Ki} G_{pt}^{\Psi_K} K_{it}\right)^{\upsilon} + \left(\beta_2 \epsilon_{Li} G_{pt}^{\Psi_L} L_{it}\right)^{\upsilon} + \left(\beta_3 M_{it}\right)^{\upsilon}\right]^{\frac{1}{\upsilon}} \tag{1}$$

G_{pt} can be written as

$$G_{pt} = T_{pt}\Phi_{pt}C_{pt} \tag{2}$$

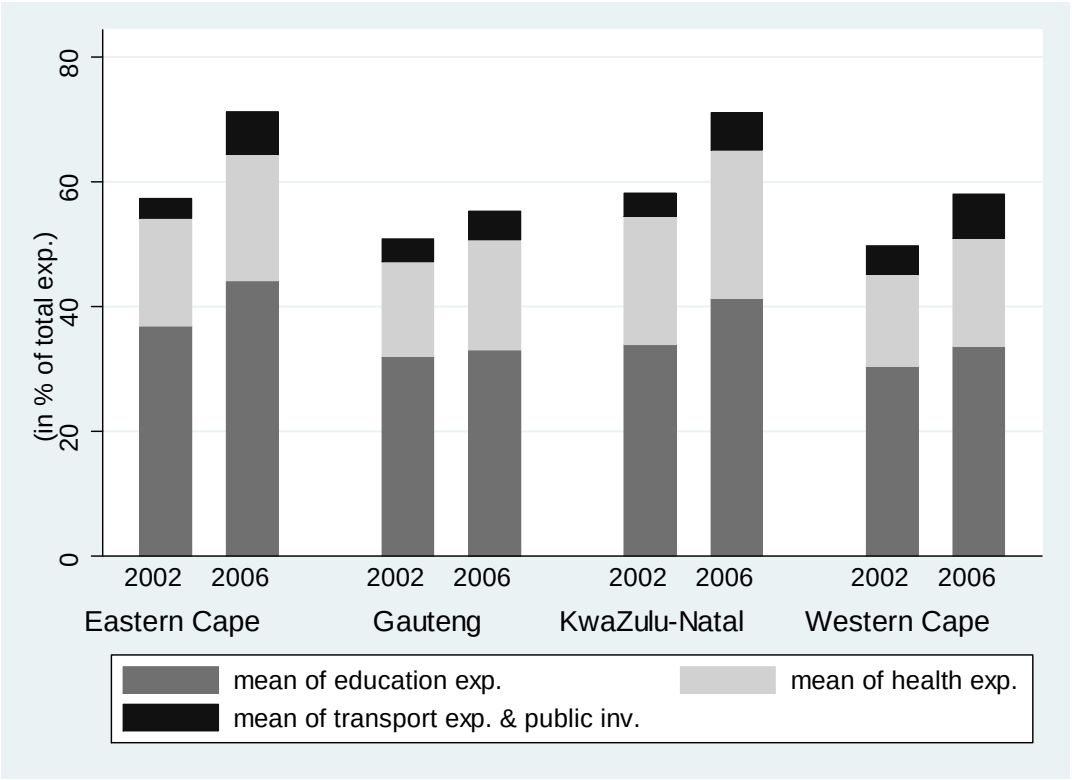
Table 3: Fiscal variables provided by the South African Treasury

Variable	**Description (all in logs)**
total expenditure	total provincial expenditure / GDP
productive expenditure	Σ prod. health exp., productive education expenditure, productive transport & capital expenditure
productive education expenditure	public ordinary school education, independent school subsidies, further education and training, adult basic training, early childhood development
prod. health expenditure	district health services, provincial hospital services
prod. transport & capital exp.	road infrastructure, public transport, traffic management
unproductive expenditure	mainly agriculture, social development, housing, sport, recreation, arts and culture, administration, education (only public special school education, auxiliary and associated services) health (emergency medical services, central hospital services, health sciences and training, health care support services, health facilities management) transport and public investment (public works, community-based programme)

Table 4: Productive public spending (not in logs)

Variable (as a share of total exp.)	Mean	Std. Dev. (overall)	Std. Dev. (between)	Std. Dev. (within)
prod. expenditure	0.552	0.070	0.068	.022
prod. education expenditure	0.339	0.032	0.032	.008
prod. health expenditure	0.174	0.024	0.023	.006
prod. transport and capital expenditure	0.047	0.010	0.009	.004

Figure 1: Productive expenditure by province



where T_{pt} denotes total public spending in a given province in year t, Φ_{pt} denotes the share of total public spending on G_{pt} (i.e., that is devoted to productive categories), and C_{pt} represents other province-specific factors that relate to the efficiency of public spending.

Including G_{pt} in the production function of firms reflects for instance the fact that private vehicles can be used more productively when the quality of the road network increases, that the cost of using private vehicles due to lower maintenance requirements falls and that labor productivity is affected by various public services, for instance by those that are health-related. This is what we refer to as the productive effects of public spending.[4]

[4]We also recognize that there may also be less direct mechanisms through which public spending affects firm productivity however. For instance, total factor productivity can be seen to also depend on factors such as capacity utilization, inventory levels and supplier relationships. Higher capacity utilization implies that the fixed costs of capital per unit produced fall, low inventory levels can be maintained when the continuous supply of inputs is ensured which likewise reduces production cost, and access to a larger number of sup-

ϵ_{Ki} and ϵ_{Li} - together with factor-specific parameters Ψ_K and Ψ_L among other factors - determine the productive effects of a given level of G_{pt}.[5] We thereby assume that some of the key parameters that determine the output elasticity with respect to G_{pt}, ϵ_{Ki} and ϵ_{Li}, are firm-specific. *A priori*, there is no reason to believe that these parameters are identical across all firms, and indeed, there is a host of reasons of why this assumption is likely to hold true. For example, the location of each firm determines access to public services and thereby the impact of G_{pt} on firm productivity. We exploit this assumption below to identify the productive effects of public spending.

An important concern in the empirical estimation of the effects of the composition of public expenditures on firm productivity is the omission of variables that are correlated with the expenditure mix and the error term in the regression. This form of endogeneity bias might be caused by time-varying changes to the preferences of regional governments towards private enterprise. For example, regions could in principle adopt a strategy of openness towards international trade and FDI in order to encourage growth and investment and compensate the (perceived) negative effects of this by voters to the security of their employment by increased welfare payments (Rodrik, 1998). Alternatively, expenditures might be targeted at particular provinces because there is some province specific factor, such as its geography, that raises (or lowers) the productivity of all firms located there. In order to control for this possibility we include in all regressions a full set of province-year effects (D_{pt}) and industry-year effects (D_{jt}) effects. We further test the robustness of our results to the possibility that regional governments might target particular industries by including province-industry-year effects.

The province-year effects that we include in the regression are obviously perfectly collinear with G_{pt} which is the variable of interest. To identify the effects of fiscal policy we instead exploit differences in their effect across

pliers may enable the firm to purchase inputs at lower prices. Public spending, especially on public infrastructure, may improve firm productivity through positively affecting these determinants of TFP. Shirley and Winston (2004) develop a theoretical argument along these lines.

[5] Ψ_K and Ψ_L are strictly speaking not necessary to derive our results and could be omitted for simplicity, but they serve to show that our results also hold in a more general setting.

firms. While differences in neither ϵ_{Ki} nor ϵ_{Li} across firms are observable, we use information on the capital-labor ratio of firms, which to again remove the effects of province or industry level factors we express as a ratio to the annual province-industry mean. We anticipate that firms that are relatively labor-intensive in their production technology compared to other firms in their industry in that region in the same year are more likely to benefit from spending on health, education and public transport for example.

It is straightforward to show that the capital intensity relative to the annual province mean, $\frac{K_{it}}{L_{it}} / \frac{K_{pt}}{L_{pt}}$, is not driven by G_{pt} itself but only by how susceptible firms are to G_{pt}.[6] Profit maximization implies that the ratio of the marginal products of labor and capital equals the ratio of factor prices. Dividing this equation by the same condition of a hypothetical firm producing mean output, Y_{pt}, using mean inputs in the same province and year yields

$$\frac{\left(\partial Y_{it}/\partial K_{it}\right) / \left(\partial Y_{it}/\partial L_{it}\right)}{\left(\partial Y_{pt}/\partial K_{pt}\right) / \left(\partial Y_{pt}/\partial L_{pt}\right)} = z \tag{3}$$

where z is a constant that is determined by differences in relative factor prices across firms in one province. If factor prices are identical across all firms, $z = 1$. Rearranging (3) yields

$$\frac{K_{it}}{L_{it}} / \frac{K_{pt}}{L_{pt}} = \left(\frac{\epsilon_{K_i}}{\epsilon_{K_p}}\right)^{\frac{\upsilon}{1-\upsilon}} \left(\frac{\epsilon_{L_i}}{\epsilon_{L_p}}\right)^{\frac{\upsilon}{1-\upsilon}} z^{\frac{1}{\upsilon-1}} \tag{4}$$

which shows that the capital intensity relative to the annual province mean is only determined by exogenous parameters, and notably by differences of ϵ_{K_i} and ϵ_{L_i} between firms which, from (1), determine the differences of the productive effects of G_{pt} across firms within one province and year.

In the econometric specification, we also take into account differences across industries, for instance in terms of the production technology. To estimate the effects of G_{pt}, we then simply group firms by their capital intensity relative to the annual-province-industry mean, i.e., whether their relative capital intensity is low, lower medium, higher medium or high based on the quartiles of the distribution of the relative capital intensities across all firms

[6] For simplicity, we abstract from differences across industries at this point which we however take into acount in the empirical specification.

in all provinces and years. We also approximate (1) using a Translog function:

$$\begin{aligned} y_{it} &= \alpha + \beta_1 k_{it} + \beta_2 l_{it} + \beta_3 m_{it} + \beta_4 k_{it}^2 + \beta_5 l_{it}^2 + \beta_6 m_{it}^2 + \beta_7 k_{it} l_{it} \quad (5) \\ &\quad + \beta_8 k_{it} m_{it} + \beta_9 l_{it} m_{it} + \beta_{10} [low]\, \phi_{pt} + \beta_{11} [lmed] \phi_{pt} \\ &\quad + \beta_{12} [hmed] \phi_{pt} + \beta_{14} D_{pt} + \beta_{15} D_{jt} + \beta_{16} D_{pj} + \beta_{17} C_{it} \end{aligned}$$

where the subscript j denotes the industry and where all variables are in logs (which is denoted by variables in lower case) which is the equation which we estimate and where *low*, *lmed*, *hmed* represent dummy variables for the firms with relative capital intensities, $\frac{K_{it}}{L_{it}} / \frac{K_{pjt}}{L_{pjt}}$, below the 25th, between the 25th and the 50th and between the 50th and 75th percentiles, respectively, which we each interact with ϕ_{pt} (the share of productive public spending in total expenditure). We do not include an indicator of *high* k/l firms, such that the effects of the public expenditure mix on low and medium capital intensity firms are measured relative to that group.[7] Given that capital and labor (in logs) are already included in various ways in the empirical specification, we do not include the capital intensity as an additional indicator in the regressions. These interaction terms therefore capture whether changes to the mix of public spending affect the production technology depending on their relative capital-labor ratios. This approach does not allow inferring the magnitude and the sign of the overall productive effects. However, it seems highly unlikely that reallocating resources from unproductive to productive expenditure categories has overall negative effects on firm productivity, and theory does not provide any plausible transmission channel for such a scenario.

Note that we have also substituted for G_{pt} using (2) where T_{pt} and C_{pt} are implicitly captured by province-time effects (D_{pt}) that we include and cannot therefore be separately interpreted. It follows that because the province-time effects include the effects of total spending, we implicitly hold this constant in the analysis. In this regard we follow a tradition established in the macro

[7] Using dummy variables for the interaction terms has the advantage that the coefficients are much easier to interpret, and as we show below, our results are robust to varying the number of capital intensity categories we use.

literature by Devarajan et al. (1996) in estimating the growth effects of changes in the public spending mix. The coefficient on ϕ_{pt} is still identified because it is interacted with the firm level measures of the capital-labor ratio and measures the effects of an increase of the share of productive expenditure offset by a decrease of other types of expenditure.

D_{jt} and D_{pj} are industry-time and province-industry effects. Together with province-time effects, D_{pt}, they control for a range of unobserved factors that affect productivity. C_{it} represent controls for differences between firms in their access to foreign technology, in foreign ownership, in export status variables and size (dummy). To control for the social environment in which firms operate we add to the regression an indicator of whether the firm has been a victim of crime.

Given the lack of a counterpart in the empirical literature, we feel that it is important to establish the robustness of our findings to a number of different methodologies. Our base regressions come from estimating (5) using data for 2002 and 2006. In order to exploit the full four years of firm data and to improve the identification of the parameter values on the private inputs in the production function, our second methodology estimates (5) in two steps. In the first step we estimate (5) including only all private inputs as right-hand side variables using all four years of available data. In this step, we include a full set of firm fixed effects and province-year effects for 2002 and 2006, to avoid any bias caused by omitting the remaining variables including the fiscal variables in this regression.[8] In the second step, we use OLS and impose the coefficients from this first stage regression on the relevant private input variables in (5) and include back in the firm and fiscal variables omitted from the first stage. This approach is of course equivalent to that used to construct measures of productivity from the residuals of an econometrically estimated production function.

Finally, concern over the possible endogeneity of investment, and therefore the capital stock, leads us to implement the estimator proposed by Levin-

[8]Given that the location of firms in 2000 and 2001 is unknown, we cannot include province-year effects for these. However, as a robustness check, we also ran regressions with no province-year effects and with province-year effects for all years.

sohn and Petrin (2003). Implementation of the Levinsohn-Petrin estimator requires at least three years of data. As already noted, whereas our firm level variables are available for up to four years, our measure of productive public spending are available for only two years. To ensure that the coefficients on the private inputs are robustly identified we again proceed in two steps. In the first step we follow the Levinsohn-Petrin estimator as usually applied: the first step properly identifies the coefficient on investment controlling for its possible endogeneity. The second step is then identical to the above and includes the fiscal variables of interest.

4 Results

In Table 5 we report results for various specifications including those from one-step, two-step and the Levinsohn-Petrin estimators, and including various combinations of industry, time, and province effects. Regression 1 in Table 5 refers to our baseline estimation and we use the remaining regressions to test the robustness of these results. In regression 1 we include province-time effects to control for province-specific components of the business cycle and other omitted province-specific variables that vary over time, including total public expenditure as well as other policy variables not directly related to fiscal policy. We also use province-industry effects to control for time invariant province-specific industry characteristics and industry-time effects to control for omitted industry-specific shocks. In all regressions, we use province-industry clustered standard errors to control for intra-class correlation. The number of provinces is too small to cluster at the provincial level only; however to further control for intra-class correlation, we use the wild cluster bootstrap indicator as proposed by Cameron et al. (2008) which we discuss further below.

Beginning with the control variables we find that the production function performs sensibly and the estimated elasticities (calculated at the means of the other right-hand side variables) are within the expected range. The elasticity with respect to physical capital and labor in regression 1 are 0.05 and 0.26 respectively and there are mildly increasing returns across all of the

private inputs for the firms in our sample. Of the firm level variables (foreign ownership, size, export status and crime) few have a significant statistical relationship with the output of the firm across Table 5. This may be a consequence of the use of a Translog production function and the relatively small number of observations compared to many of the micro level studies that have examined the relationship between internationalization and firm productivity.

Turning next to the fiscal variables in regression 1, the results for the productive expenditure variable can be interpreted as the effect on firm level productivity from an increase in the share of productive expenditures compensated by a pro-rata decrease in types of non-productive expenditure, leaving total expenditures constant. Regression 1 suggests that this type of fiscal policy change is associated with higher firm productivity for those firms with a relatively low ratio of capital to labor (relative to the respective province-industry-year mean). Our estimates imply that a 1 per cent change in the expenditure mix towards productive expenditure is associated with a rise in firm output of 0.22 per cent. According to this result, changes in government expenditure have a stronger effect on output than changes in private capital for these firms.

To evaluate the magnitude of these effects further, from Table 4 we calculate that the average increase in the share of productive expenditure within South African provinces over time (relative to the mean) was equal to 4 per cent (the mean is 0.552 and the within province standard deviation 0.022). Multiplying this number with the coefficient estimate suggests that the productivity-enhancing effects of changes to the expenditure mix is equal to 0.88 per cent for firms with a low capital-labor ratio. The magnitude of these effects is economically important. The average change in sales over time measured by the within standard deviation divided by the mean of firms with a low relative capital intensity is 3.94 per cent, such that fiscal policy contributed an estimated 22 per cent of this change.

For firms with medium capital-labor ratios we find evidence of positive, statistically significant effect from the productive expenditure share on their productivity. That the estimated elasticity of public spending on firm per-

formance is strongest and significant for firms in the bottom quartile of the distribution for the relative capital-labor ratio may be a consequence of the types of fiscal categories that we label as productive, such as education, health and public transport. Data limitations on the panel element of our dataset prevent us from exploring whether the effects differ over the long run across firm types, but in Table 7 below we discuss results where we broaden and narrow the types of expenditures we consider as 'productive'.

In regression 1 we identify the effects of changes to the mix of public expenditures by using differences in their impact across firms after controlling for all time-varying province and industry level factors that may affect a firms' productivity along with time-invariant province-specific industry factors. In regression 2 we control for the possibility that there are difficult to observe factors at the province-industry-time level that affect firms' productivity and are correlated with the fiscal expenditure mix. Our results are left unchanged from the inclusion of these province-industry-year dummies. We continue to find evidence that those firms that have a low ratio of capital to labor relative to other firms in their industry in that province are positively affected by shifting the expenditure mix towards productive categories and away from unproductive ones. We now also find that the magnitude of this effect is roughly identical to regression 1. For firms with a medium relative capital intensity, the magnitude of the effect increases relative to regression 1 and remains significant. This is a persistent feature of the results we present; the positive effect of public spending on firms that use more labor relative to capital is robust.

In specifications 3 and 4 of Table 5, we consider the robustness of our findings to the two-step estimation strategy outlined above, where we use all four years of firm level data to improve the identification of the parameters on the private inputs in the production function. In the first stage of specification 3, we include firm fixed effects and province-time effects for 2002 and 2006. Again the results are robust to this point.[9] In the two-stage estimation results we continue to find that the coefficients on the fiscal variables are sta-

[9]The standard errors of the output elasticities with respect to the private inputs also come from the first stage.

tistically significant and that the estimated elasticities are largely unchanged. Changing the mix of province-level expenditures towards productive spending categories and away from unproductive categories whilst holding the total budget constant, is associated with increases in firm level output for firms with a low capital intensity.

A similar outcome occurs when we use the Levinsohn-Petrin estimator in the first stage of our 2-step estimation strategy to correct for the endogeneity of the estimated coefficients on private inputs (specification 4 in Table 5). When using the Levinsohn-Petrin estimator we find that the estimated coefficients on productive expenditures for the low capital intensity groups are now larger compared to the previous regressions in 5, but still significant. Finally, in regression 5 we use the wild cluster bootstrap estimator proposed by Cameron et al. (2008) to further control for intra-class correlation at the province and industry level. In this specification, we are technically only able to include province-year effects. The coefficient on the share of productive expenditure for firms with a low capital intensity remains significant and robust, although their magnitude decreases.

5 Robustness of the Results

In Table 6 we consider the robustness of our results to changes in the definition of productive expenditures as well as other firm-expenditure interactions. Thus far we have used differences in the relative factor intensity of capital and labor in the firms' production function to identify the effects of changes to the public expenditure mix on their performance. It follows from the decision to express these capital-labor ratios relative to the mean value in each industry, province and year, along with the province-time and province-industry dummies that we include, that our results cannot be explained by differences in the characteristics of particular industries, or because province-specific differences in relative input prices lead to different factor intensities across provinces. Firms from the various industries and provinces are spread across the different quartiles. Along similar lines our results cannot reflect the decision by an entrepreneur to open a firm producing a particular type of product

in a particular province because the expenditure mix in that province favors a production technology of that type. Such effects will instead be reflected in the mean value of the capital-labor ratio.

The possibility that other firm level variables might explain our results, or may also be important, remains however. For example, if larger firms tend to be on average more capital intensive than smaller firms then it might be the relative size of firm, rather that capital-labor intensity, that is important. Alternatively, it is now well established in the international economics literature that exporters and foreign owned firms are larger and more productive than firms that are not internationalized in these ways and it is possible that these are the relevant firm characteristics. In the regressions in Table 6 we consider this possibility. In specification 1 in Table 6, we also include interactions between export status and the share of productive expenditure. The results show that the coefficients remain robust and statistically significant, whereas the interaction term of the share of productive public spending in total expenditure with export status is not significant. In specifications 2 and 3, we consider whether productive expenditure has different effects on large firms or firms that are (partially) foreign owned. (i.e., we interact the share of productive expenditure with the respective dummies). According to our results, this is not the case.

In the remaining regressions in Table 6 we use the amount of labor, relative to the province-industry mean, (regression 4) and the size of the capital stock, measured relative to the province-industry mean, (regression 5) as the relevant firm characteristics implying that the *low*, *lmed.* and *hmed.* dummies refer to these variables relative to the annual province-industry mean. In all cases, we again use province-time, industry-time and province-industry effects to control for other omitted determinants of productivity. We do not find that the share of productive expenditures matters for any of these types of firm. Firms that are small, or medium sized, when measured by either the amount of labor or capital they possess relative to the annual average firm in their industry and province, are not significantly affected by the mix of public expenditures. We conclude from this exercise that the relevant firm characteristic is their use of physical capital relative to labor and that firms

that have relatively low capital-labor ratios are positively affected by the types of productive public expenditures we examine.

In Table 7, we further test the robustness of our results. In specification 1 of Table 7, we add firm fixed effects. Even though we only have two years of data, our results remain robust. So far, in our specifications, total unproductive expenditure, i.e., expenditure within the health, education and transport sectors and in other sectors, has implicitly been the omitted expenditure category in the sense that we assumed that this type of expenditure compensated, on a pro-rata basis, an increase of productive expenditure. Even though we control for unobserved, time-variant province-specific effects, there may still be the concern that the share of productive expenditure in total expenditure is affected by economic shocks because included within the denominator are transfers and similar expenditures that may exhibit some pro-cyclical behavior. Specification 2 addresses this concern: instead of including productive expenditure as a share of total expenditure, we now express productive expenditure as a share of total expenditure on education, health and transport sectors. Here, we assume that whilst the level of spending on health, education or transport may respond to random shocks to the economy, within those categories the spending decisions are made based on different policy priorities. For example, the share of spending on emergency medical services or administration is a policy decision unaffected by the position in the business cycle, even if total health expenditure is affected. Specification (2) suggests that our results remain robust and that reallocating resources from unproductive areas in the education, health and transport sectors to productive areas positively and significantly affects firm productivity in the bottom capital-labor ratio group, although the effects in the medium group are not significant.

We then test whether our results are driven by the particular way in which we group firms based on their relative capital intensity. In specification (3), instead of using quartiles, we use quintiles of the distribution of the relative capital intensities across all firms in all provinces and years and therefore distinguish the effects of public spending across five groups of firms. In specification (3), our results remain robust in the sense that the effects of the

share of productive public spending is largest and significant in the bottom group.[10]

In the remaining two specifications of Table 7, we test whether our results are driven by the particular way in which we define productive expenditure. Thus far we have used a particular definition and include sub-categories of education, health and transport as well as capital expenditure that may be expected to be productive over the short run. When we include all sub-categories of health, education and transport as well as capital expenditure, where this now includes expenditures on administration, in specification (4), the coefficient of the share of productive expenditure is again statistically significant. That the coefficient also increases suggests perhaps that our initial assumptions was too severe and that these other sub-categories have important productive effects over the short to medium run. In specification (5), we are more selective and only include few subcategories of education, health and transport spending. We exclude all education spending on the grounds that their productive effects may be subject to longer lags and only include early childhood development based on the notion that this increases labor productivity of the parents. We exclude all health spending except for district health services, which is likely to have more immediate effects on labor productivity compared to provincial health services which in part may be targeted at those people who are severely sick and who are hence not part of the labor force. Finally we include spending on public transportation spending but now exclude any transport management and transport infrastructure spending. The coefficient decreases in size, but remains positive and significant in this regression.

6 Conclusions

This paper examines whether changes in the composition of public spending affects firm productivity and whether these effects depend on firm characteristics. Since it is well known that estimating production functions gives rise to

[10] Our results also remain robust to using terciles of the distribution of the relative capital intensities (not shown).

various biases, we use a variety of estimators and econometric specifications. We show that in general the composition of public spending matters for firm productivity, and that there is robust evidence that its effects vary across firms depending on their capital intensities relative to the annual province-industry mean. Firms that are labor intensive in relative terms appear to benefit to a greater extent from the forms of productive spending that we consider compared to more capital intensive firms. Our identification strategy which we have derived from a standard production function framework allows us to control for any omitted province-specific time and industry effects.

We leave several possible extensions for future work. The robustness of the results could be further tested through the use of additional estimators and empirical methods. Our identification strategy probably addresses potential endogeneity more convincingly than most other papers that analyze the productive effects of public spending, both at the macro and micro level. Nevertheless, concerns may still remain. For instance, our identification strategy does not allow controlling for provincial differences in the relative productivity of low capital-labor ratio firms relative to high capital-labor ratio firms which could affect our results. One constraint of our data is certainly the availability of firm information across fairly short time periods, but we argued that productive effects arising over the medium run are plausible, and as a robustness checks, we further narrow the subcomponents of education, health and transport expenditure that we consider as having productive effects over the medium run. In addition, the type of data we use in combination with our empirical specification implies that we are unable to evaluate the aggregate effects of changes in public spending composition on firm productivity. However, from a theoretical point of view, it seems highly unlikely that changes in the composition of public spending in favor of productive categories lower overall private sector productivity. In this sense, our finding that productive public spending positively affects productivity of firms with a relatively low capital intensity implies that the productivity of these firms increases in absolute terms, and not only relative to firms with a high capital intensity. There are other aspects of the dataset that could be

exploited further. For instance, it would be possible to compare the effects of different components of productive public spending; to compare the effects of aggregate productive public spending when offset by different elements of the government budget; and it would be possible to explore the role of additional firm characteristics for the effects of public spending.

In contrast to other studies that evaluate the productive effects of public expenditure empirically, we fully take into account the government budget constraint *and* firm characteristics simultaneously. This feature allows us to draw well founded policy conclusion. First, governments are able to boost firm productivity by reallocating a greater share of public spending towards productive expenditure categories. Given that productivity at the firm level is likely to be fundamental for long-run, aggregate economic growth, this is less expensive than raising overall public spending including productive spending. This is of current relevance given the large budget deficits due to the recent economic crisis in many countries. Changing the composition of public spending, rather than raising productive spending and leaving unproductive spending unchanged which in turn increases the overall level of public spending and may require issuing debt for example, would seem from our evidence to be one feasible option of how fiscal policy can be used to increase the medium- to long-run growth potential of the economy. Second, if governments attempt to raise firm productivity via the reallocation of public resources, it is however important that they take into account the characteristics of firms. While this issue needs to be further explored in future research, it seems reasonable that for instance, the effects of public spending and its components depend on the technology of firms that in turn drives their capital intensities.

Table 5: Results

VARIABLES	(1) sales	(2) sales	(3) sales	(4) sales	(5) sales
capital	0.0481***	0.0420**	0.0322	0.0100	0.0585
	(0.0180)	(0.0202)	(0.0623)	(0)	
labor	0.258***	0.264***	0.222***	0.218***	0.253
	(0.0300)	(0.0202)	(0.0415)	(0)	
materials	0.719***	0.719***	0.743***	0.760***	0.714
	(0.0191)	(0.0338)	(0.0239)	(0)	
foreign	0.0305	0.0264	0.0363	0.0614**	0.0509***
	(0.0268)	(0.0278)	(0.0299)	(0.0293)	
large	0.0310	0.0356	0.0954***	0.0980***	-0.00309
	(0.0377)	(0.0396)	(0.0327)	(0.0309)	
exporter	0.0198	0.0197	0.0275	0.0168	0.0392
	(0.0242)	(0.0248)	(0.0301)	(0.0302)	
crime	-0.0200	-0.0151	-0.0263	-0.0277	-0.0270**
	(0.0154)	(0.0161)	(0.0165)	(0.0171)	
prod. exp. low($[K_{it}/L_{it}]/[K_{jpt}/L_{jpt}]$)	0.221**	0.256**	0.256***	0.359***	0.149***
	(0.0939)	(0.109)	(0.0787)	(0.0774)	
prod. exp. lmed.($[K_{it}/L_{it}]/[K_{jpt}/L_{jpt}]$)	0.125*	0.149*	0.123**	0.220***	0.0939***
	(0.0651)	(0.0755)	(0.0486)	(0.0481)	
prod. exp. hmed.($[K_{it}/L_{it}]/[K_{jpt}/L_{jpt}]$)	0.0745	0.0752	0.0447	0.106	0.0722
	(0.0607)	(0.0647)	(0.0687)	(0.0680)	
Constant	3.040***	2.840***	4.346***	2.802***	2.859
	(0.404)	(0.409)	(0.199)	(0.0506)	
Observations	1,113	1,113	1,113	1,113	1,113
R^2	0.975	0.975			0.970
Province-Year FE	YES	NO	YES	YES	YES
Industry-Year FE	YES	NO	YES	YES	NO
Province-Ind. FE	YES	NO	YES	YES	NO
Prov.-Ind.-Year FE	NO	YES	NO	NO	NO

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

(1)-(4): ind.-prov. clustered standard errors in parentheses

(1),(2): OLS estimation based on 2002 and 2006

(3),(4): 2-step estimation; 1st step based on 2000, 2001, 2002 and 2006

and includes private inputs, province-year dummies (for 2002 and 2006)

2nd step: based on 2002 and 2006 and coefficients of private inputs imposed

1st step in (3): firm FE. 1st step in (4): LP estimation

(5): CGM Wildboot with clustering at prov. and ind. level

Unproductive spending omitted fiscal category.

Table 6: Robustness I

VARIABLES	(1) sales	(2) sales	(3) sales	(4) sales	(5) sales
capital	0.0482***	0.0477**	0.0484***	0.0755***	0.0576***
	(0.0180)	(0.0293)	(0.0191)	(0.0282)	(0.0194)
labor	0.258***	0.257***	0.258***	0.244***	0.232***
	(0.0301)	(0.0190)	(0.0300)	(0.0198)	(0.0195)
materials	0.719***	0.719***	0.719***	0.720***	0.718***
	(0.0190)	(0.0180)	(0.0179)	(0.0120)	(0.0251)
foreign	0.0308	0.0306		0.0280	0.0295
	(0.0269)	(0.0267)		(0.0276)	(0.0270)
large	0.0311		0.0311	0.0277	0.0238
	(0.0376)		(0.0375)	(0.0330)	(0.0369)
exporter		0.0206	0.0203	0.0192	0.0202
		(0.0241)	(0.0244)	(0.0241)	(0.0248)
crime	-0.0199	-0.0200	-0.0205	-0.0207	-0.0194
	(0.0154)	(0.0155)	(0.0154)	(0.0152)	(0.0149)
prod. exp. low	0.220**	0.224**	0.220**	-0.0845	0.198
	(0.0939)	(0.0944)	(0.0935)	(0.126)	(0.138)
prod. exp. lmed.	0.124*	0.127*	0.124*	0.00714	0.141
	(0.0652)	(0.0662)	(0.0649)	(0.0791)	(0.105)
prod. exp. hmed.	0.0742	0.0756	0.0739	0.0196	0.0531
	(0.0606)	(0.0605)	(0.0606)	(0.0576)	(0.0698)
prod. exp. [exporter]	-0.0253				
	(0.0325)				
prod. exp. [large]		-0.0589			
		(0.0665)			
prod. exp. [foreign]			-0.0389		
			(0.0388)		
Constant	3.034***	3.046***	3.042***	2.016***	3.174***
	(0.404)	(0.402)	(0.403)	(0.446)	(0.423)
Observations	1,113	1,113	1,113	1,113	1,113
R^2	0.975	0.975	0.975	0.975	0.975
Province-Year FE	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES
Province-Ind. FE	YES	YES	YES	YES	YES
Prov.-Ind.-Year FE	NO	NO	NO	NO	NO

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ind.-prov. clustered standard errors in parentheses

OLS estimates based on 2002 and 2006.

(1) share of prod. exp. interacted with export status

(2) share of prod. exp. interacted with size category

(3) share of prod. exp. interacted with foreign ownership

(4) relative labor use interacted with share of prod. exp.

(5) relative capital use interacted with share of prod. exp.

Unproductive spending omitted fiscal category.

Table 7: Robustness II

VARIABLES	(1) sales	(2) sales	(3) sales	(4) sales	(5) sales
dlny/dlnk	-0.00379	0.0510***	0.0474**	0.0494	0.0484**
	(0.0306)	(0.0296)	(0.0180)	(0.0301)	(0.0302)
dlny/dlnl	0.448***	0.255***	0.259***	0.258	0.258***
	(0.0876)	(0.0190)	(0.0303)	(0.0192)	(0.0185)
dlny/dlnr	0.697***	0.719***	0.719***	0.719	0.719***
	(0.0303)	(0.0181)	(0.0191)	(0.0171)	(0.0191)
foreign	-0.0355	0.0306	0.0302	0.0300	0.0309
	(0.102)	(0.0268)	(0.0273)	(0.0268)	(0.0269)
large	-0.0354	0.0306	0.0313	0.0301	0.0290
	(0.151)	(0.0379)	(0.0376)	(0.0375)	(0.0377)
exporter	-0.0515	0.0197	0.0197	0.0199	0.0201
	(0.0841)	(0.0244)	(0.0243)	(0.0242)	(0.0242)
crime	0.0223	-0.0205	-0.0201	-0.0195	-0.0203
	(0.0412)	(0.0154)	(0.0155)	(0.0154)	(0.0154)
prod. exp. low($[K_{it}/L_{it}]/[K_{jpt}/L_{jpt}]$)	0.450***	0.308*	0.227**	0.587***	0.0541**
	(0.105)	(0.155)	(0.0970)	(0.219)	(0.0244)
prod. exp. lmed.($[K_{it}/L_{it}]/[K_{jpt}/L_{jpt}]$)	0.303***	0.175	0.130*	0.326**	0.0304*
	(0.0788)	(0.107)	(0.0659)	(0.159)	(0.0166)
prod. exp. hmed.($[K_{it}/L_{it}]/[K_{jpt}/L_{jpt}]$)	-0.0150	0.109	0.0789	0.179	0.0211
	(0.128)	(0.0991)	(0.0544)	(0.148)	(0.0160)
prod. exp. hmed2.($[K_{it}/L_{it}]/[K_{jpt}/L_{jpt}]$)			0.0141		
			(0.0758)		
Constant	4.440***	3.021***	3.041***	3.048***	3.062***
	(0.950)	(0.403)	(0.403)	(0.405)	(0.402)
Observations	1113	1113	1113	1113	1113
R^2	0.966	0.975	0.975	0.975	0.975
Number of eec_panelid	981				
Province-Year FE	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES
Province-Ind. FE	YES	YES	YES	YES	YES
Firm FE	YES	NO	NO	NO	NO

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

ind.-prov. clustered standard errors in parentheses

OLS estimates based on 2002 and 2006

(1) firm fixed effects

(2) prod. edu., health and transp. exp. as a ratio of all exp. in these categories

(3) relative capital intensity categories based on 20th percentiles intervals

(4) broad expenditure categories used

(5) narrow expenditure categories used

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