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Urbanization with and without industrialization

Douglas Gollin[1] · **Remi Jedwab**[2] · **Dietrich Vollrath**[3]

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Abstract We document a strong positive relationship between natural resource exports and urbanization in a sample of 116 developing nations over the period 1960–2010. In countries that are heavily dependent on resource exports, urbanization appears to be concentrated in "consumption cities" where the economies consist primarily of non-tradable services. These contrast with "production cities" that are more dependent on manufacturing in countries that have industrialized. Consumption cities in resource exporters also appear to perform worse along several measures of welfare. We offer a simple model of structural change that can explain the observed patterns of urbanization and the associated differences in city types. We note that although the development literature often assumes that urbanization is synonymous with industrialization, patterns differ markedly across developing countries. We discuss several possible implications for policy.

Keywords Economic development · Structural change · Industrial revolution · Natural resource revolution · Urbanization

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✉ Dietrich Vollrath
devollrath@uh.edu

Douglas Gollin
Douglas.Gollin@qeh.ox.ac.uk

Remi Jedwab
jedwab@gwu.edu

1 Department of International Development, University of Oxford, Queen Elizabeth House, 3 Mansfield Road, Oxford OX1 3TB, United Kingdom

2 Department of Economics, George Washington University, 2115 G Street, NW, Washington, DC 20052, USA

3 Department of Economics, University of Houston, 201C McElhinney Hall, Houston, TX 77204, USA

1 Introduction

Developing countries have urbanized dramatically over the last 50 years. This episode of massive urbanization shares many similarities with the historical urbanization process of today's developed countries. As in the historical experience, urbanization in today's developing countries is closely linked to increasing income per capita. Indeed, the correlation is so strong that urbanization is often used as a proxy for income per capita in comparisons across time and space (De Long and Shleifer 1993; Acemoglu et al. 2002). There is also a virtuous circle between economic development and urbanization (Henderson 2010; Duranton 2013; Glaeser 2013; Jedwab and Vollrath 2015b). As countries develop, people move out of rural areas and agricultural activities into urban centers, where they engage in manufacturing and service activities (Gollin et al. 2002; Michaels et al. 2012). These non-agricultural sectors are generally thought to have high rates of productivity growth, and agglomeration effects in urban areas are also believed to promote further economic growth (Glaeser et al. 1992; Duranton 2008; Glaeser and Gottlieb 2009).

The historical pattern in the European and Neo-European countries that have undergone significant urbanization (beyond 50 %) has been that urbanization has accompanied industrialization; with the factories came the cities. In many developing countries, however, urbanization has deviated from this pattern. Many of today's developing countries have high rates of urbanization with little significant industry. Kuwait, Gabon, Saudi Arabia, Libya, Algeria, Angola and Nigeria are as urbanized as Uruguay, Taiwan, South Korea, Mexico, Malaysia, South Africa and China respectively, and yet the former countries have not industrialized to the same extent as the latter. This raises several questions. What has driven the urbanization process in Angola, Nigeria, and the others, in the absence of industry? Why have so many cities in today's developing world never been factory cities, in stark contrast to the historical experience of today's developed countries? If these cities have a different origin, does it matter for economic development?

In this paper, we document that the expected relationship between urbanization and industrialization is absent in large parts of the developing world. The breakdown in this relationship occurs because of a large number of natural resource exporting countries that urbanized without significantly increasing the share of output from manufacturing and/or tradable services in GDP. Using a sample of 116 developing countries observed each decade from 1960–2010, we show that under a variety of specifications there is a statistically significant and economically meaningful association of resource exports with the urbanization rate. This is estimated holding constant the share of manufacturing and services in GDP. In our preferred specification, a one standard deviation increase in resource exports is associated with a 0.51 standard deviation increase in the urbanization rate, which equates to a roughly 13 % point increase.

The effect of resource exports on urbanization holds not only in the cross-section but also in a panel that uses within-country variation for identification. These specifications are robust to adding region-decade fixed effects (Western Africa in the 1960s, etc.). Our results hold when incorporating a variety of controls for confounding effects. Different means of measuring the role of natural resource exports—as a percent of GDP, value per capita, or including only fuel and mining exports—do not qualitatively alter the results.

Following the existing literature (Sachs and Warner 2001; Brückner 2012; Henderson et al. 2013b), we also use resource discoveries and international commodity price shocks as instruments for resource exports to provide further evidence of causality. One can think of our approach as being similar to a "difference-in-difference" estimator, where countries that find a new resource (e.g. Botswana discovering diamonds in 1968) are the treatment group. The control groups are countries that either never discovered a resource in this period or were producing a natural resource the entire time. The IV results are consistent with our cross-section and panel findings.

Having established this relationship between natural resource dependence and urbanization, we then consider whether urbanization in resource-exporting countries differs substantially from urbanization in industrializing countries. In the cross-section, the strong positive relationship between income and urbanization is similar regardless of the source of urbanization. In fact, conditional on income per capita, urbanization rates are unrelated to the share of resource exports in GDP or the share of manufacturing and services in GDP. Urbanization is a function of income per capita across all countries.

However, the *composition* of urban employment differs starkly between resource-exporters and non-exporters, holding constant income levels and urbanization rates. We use IPUMS census micro-data, labor force surveys, and household survey data to recreate the sectoral composition of urban areas for a sub-sample of 88 countries. Using this novel data set, we find that cities in resource-exporting countries are what we term "consumption cities", with a larger fraction of workers in non-tradable services such as commerce and transportation or personal and government services.[1] Cities in countries that do not export significant resources, on the other hand, appear to be "production cities", with more workers in industrial sectors such as manufacturing or in tradable services like finance.

The differences between consumption cities and production cities are not limited to employment patterns. We show that, in addition, cities in resource-exporters tend to have higher poverty rates and shares of population in slums than non-exporters, holding constant income levels and urbanization rates. Unconditionally, however, resource exporters are better off than non-exporters on these various measures of urban welfare. Our interpretation is that the income boost from resource exports makes cities richer, but it does not appear to translate into improved quality of life to the same degree that an income boost through industrialization would provide. Our findings could be seen as an example of "premature urbanization" (rather than "premature deindustrialization" as in Rodrik 2013a). Whether this constitutes a resource curse is not clear. As we show, the high urbanization rates in resource exporters are driven by high incomes; so in that sense, there is no evidence for a resource curse. Yet the "consumption cities" of resource exporters may not offer all the welfare advantages of "production cities".[2]

To understand how resources are related to urbanization, we develop a model of labor allocations between rural and urban areas that allows for two types of urban employment: trad-

[1] For example, The Economist (2012) writes: "Angola is now one of Africa's economic successes—thanks almost entirely to oil. [...] Teams of gardeners are putting the finishing touches to manicured lawns, palm trees, tropical shrubs and paved walkways. Soon these will stretch the whole way along the Marginal, the seafront road that is being turned into a grand six-lane highway sweeping around the horseshoe-shaped bay of Luanda, Angola's buzzing capital. Modern offices, hotels and apartment blocks are sprouting up behind. [...] fancy yachts and speed boats crowd the shores of the Ilha, a once almost deserted strip of sand used mainly by poor fishermen, on which smart restaurants and nightclubs for the new elite are now springing up. [...] Shiny shopping malls are filled with everything the Angolan heart could desire, from gourmet food to the latest fashions and car models. Prices are wildly inflated. Virtually everything [...] has to be imported."

[2] Weber (1922) also contrasts "consumption cities" and "production cities". In his description, the former are cities that serve the needs of a political elite, while the latter address the needs of manufacturers and merchants. In his view, consumption cities emerge from rent redistribution rather than rent generation, and they are thus not that different from the "parasitic cities" of Hoselitz (1955) and urban bias theory. While we do not explicitly account for urban bias, this would augment the effects of resource exports on urbanization, not eliminate them. Moreover, our consumption cities are distinct from the "consumer cities" of Glaeser et al. (2001). Using U.S. data, Glaeser et al. (2001)show that high-amenity cities have grown faster than low-amenity cities, and urban rents have gone up faster than urban wages in those locales.

ables and non-tradables.[3] An exogenous increase in resource export earnings raises incomes, which in turn increases demand for all types of output. The export earnings from resources are used to purchase additional food and other tradable goods on the world market; meanwhile, the increased demand for urban non-tradables is met by an increase in labor in that sector. This result echoes the standard Balassa-Samuelson framework and also corresponds in some respects to a standard model of "Dutch Disease" (Corden and Neary 1982; Matsuyama 1992; Harding and Venables 2013), where resource exports lead to a contraction of employment in other tradable sectors but expand non-tradable employment. In our model, resource rents cause an increase in the urbanization rate as the rural sector contracts, and there is a shift in the composition of urban employment towards non-tradable workers. Urbanization generated by resource rents differs from urbanization generated by industrialization, which occurs when industrial productivity increases. In the latter, substitution effects pull labor into the urban industrial sector, in addition to the income effects which draw labor into non-tradable production.

Our results illustrate that urbanization and industrialization are not synonymous and that significant amounts of urbanization can and will take place in response to income shocks from resource exports. But resource-exporting countries may urbanize without acquiring the industrial sectors that we typically associate with development. The "consumption cities" of resource-exporters may nevertheless exert an influence on growth.[4] These cities have higher shares of non-tradable service workers and lower shares of industrial sector workers. Much research in the growth literature (Lucas 2009; Duarte and Restuccia 2010; Rodrik 2013b) suggests that convergence is faster in industry than in services. This suggests that the *source* of urbanization (resource exports or industrialization), while inconsequential with regard to the *level* of urbanization, may be consequential for long-run development. To pick up the example of the countries mentioned above, Kuwait, Libreville, Riyadh, Tripoli, Algiers, Luanda and Lagos have relatively fewer workers in manufacturing and tradable services than Montevideo, Taipei, Seoul, Mexico City, Kuala Lumpur, Johannesburg and Shanghai respectively, in spite of similar aggregate levels of income and urbanization. It is not clear that resource-led consumption cities will generate the same kind of productivity growth associated with cities in industrializing countries.

The remainder of this paper is organized as follows. Section 2 presents a model of structural change that frames the empirical investigation to follow. Section 3 describes the data

[3] The model is related to a large body of work on structural change and the decline in agriculture; see Herrendorf et al. 2011 for a full survey of the literature. Schultz (1953), Matsuyama (1992), Caselli and Coleman II (2001), Gollin et al. (2002) and Michaels et al. (2012) focus on the "food problem" and how agricultural productivity pushes labor out of agriculture (and possibly into cities). Lewis (1954), Hansen and Prescott (2002) and Lucas (2004) suggest that industrial sector productivity will pull labor out of agriculture. A relatively small literature considers structural change within an open economy (Matsuyama 1992, 2009; Galor and Mountford 2008; Yi and Zhang 2011; Glaeser 2013).

[4] This is not the only possible relationship between urbanization and development, obviously. If the country experiences a Green Revolution, the rise in food production releases labor for the urban sector (Gollin et al. 2007). Rural poverty due to natural disasters can cause rural migrants to flock to cities (Barrios et al. 2006; Henderson et al. 2013a). There are various urban pull factors. If the country experiences an Industrial Revolution, the urban wage increases, which attracts workers from the countryside (Alvarez-Cuadrado and Poschke 2011). If the government adopts urban-biased policies, urban wages increase (Ades and Glaeser 1995; Davis and Henderson 2003; Henderson 2003). Lastly, natural increase in the cities has also become a driver of urbanization in the developing world (Jedwab et al. 2014; Jedwab and Vollrath 2015a). With either a green revolution or an industrial revolution—a productivity increase in agriculture or industry, respectively—urbanization would normally be associated with growth. By contrast, theories in which urbanization is driven by rural poverty, urban bias or urban natural increase will typically imply that urbanization occurs without growth (Fay and Opal 2000; Jedwab and Vollrath 2015b). Our work implies a complementary explanation for urbanization without industrialization.

and presents stylized facts regarding resources and urbanization. Section 4 provides formal estimates of the relationship between resources and urbanization, while Sect. 5 empirically examines the consequences of resource-led urbanization. Section 6 concludes.

2 A model of urbanization and structural change

To illustrate why industrialization and urbanization need not be synonymous, and to provide guidance to our empirical work, we develop a simple model of structural change that allows for Dutch Disease effects. The basic logic is that urbanization is driven by income effects. Any income shock—whether caused by industrial productivity or resource revenues—will cause a shift away from economic activities based in rural areas and will move production into urban areas. The source of the shock *does* matter for which sector the new urban workers will be employed in, through substitution effects. More specifically, urban production will consist of a *Tradables* sector that produces goods or services that can be internationally traded, and a *Non-tradables* sector. We use the term Tradables to refer to manufacturing as well as tradable services such as finance, insurance and business services. Non-tradables are meant to encompass government and personal services as well as local retail, transportation, construction, education and health. Rural production consists only of food, which we treat as a tradable good.[5]

Natural resources will be introduced as a “manna from heaven” endowment of export earnings, requiring no labor for production and having no domestic demand. The amount of resources, though, will influence the domestic allocation of labor across the other sectors through income effects. A discovery or significant expansion of natural resource revenues in an economy will have several effects. First, the income effect will, through the non-homotheticity in demand for food, push workers into the urban sectors. Second, by increasing export earnings, it allows workers to move out of both the food and tradable sectors and shift into non-tradable production. This is the typical Balassa-Samuelson or Dutch Disease effect. Finally, urbanization will rise as the increase in urban non-tradable employment outweighs any loss of urban tradable labor. The net effect is that resource booms lead to “consumption cities” that are dominated by non-tradable sector workers.

In contrast, some economies lack significant resource revenues. For them, urbanization only arrives through tradable sector productivity increases. This causes a substitution towards the tradable sector and away from rural food production, but the income effect also induces some expansion of non-tradable urban labor. On net, urbanization will increase as both urban tradable and non-tradable labor forces expand. The composition of these cities is characteristic of what we describe as “production cities,” with an expanding number of tradable workers alongside growing non-tradable sectors.

The model formalizes these paths to urbanization. It shows that while income effects cause urbanization to occur, the nature of the structural change associated with this urbanization is not homogeneous. In short, it is possible to urbanize either with industrialization (through productivity improvements) or without industrialization (through resource revenues).

2.1 Utility, production, and equilibrium

We assume that individuals have a log-linear utility function over the three goods: food produced in rural areas (c_f), urban tradable goods (c_d), and urban non-tradables (c_n),

[5] We could explicitly incorporate a rural non-tradable sector or a rural industrial sector, but this would not change the logic of the model unless individuals had an income elasticity for rural output strictly larger than one. As noted in Sect. 2, though, 91 % of agricultural workers are in rural areas.

$$U = \beta_f \ln\left(c_f - \overline{c}_f\right) + \beta_d \ln c_d + \beta_n \ln c_n, \tag{1}$$

where β_f, β_d, and β_n are all between zero and one, and $\beta_f + \beta_d + \beta_n = 1$. The term $\overline{c}_f$ is a subsistence requirement for food, in the Stone-Geary sense, which makes the preferences non-homothetic. The income elasticity for rural food will be less than one, ensuring that any income increase will drive up the budget share for non-tradables and for urban tradable goods. Note that natural resources do not enter the utility function directly for consumers in our model economy; they will serve only as a source of export earnings.

There are domestic sectors producing each of the three goods. Production in each sector is

$$Y_j = A_j L_j^{1-\alpha}, \tag{2}$$

where $j \in (f, d, n)$ denotes the specific sector of production. The productivity level, A_j, captures any effects of capital and/or land in production. We implicitly hold those constant across sectors: we set the value of α to be identical across all sectors. The functional form also shows that there are diminishing marginal products of labor in each production activity. This ensures that there will be an incentive to have workers in each sector. We presume that the total measure of workers in the economy is equal to one, so that $L_f + L_d + L_n = 1$, and therefore each L_j term can be interpreted as the share of labor working in that sector.

There is a natural resource produced in the economy, but there is no domestic demand for it, and it is only exported. The total revenue from exporting this resource is denoted by R, and this is taken as given by individuals and producers. For simplicity, we assume that the amount R is distributed equally across all individuals, but this need not be the case. We can allow for some inequality in the distribution of resource revenues between owners and non-owners, as shown in the Web Theory Appendix, but this will not change the qualitative results regarding the role of resources on urbanization.

The tradable goods have international prices, p_f^* and p_d^*, that are taken as given by consumers and producers. The price of the urban non-tradable good is determined endogenously and is denoted by p_n. Taking these prices as given, the budget constraint for the individual is

$$p_f^* c_f + p_d^* c_d + p_n c_n = m, \tag{3}$$

which can be more usefully rewritten as

$$p_f^*\left(c_f - \overline{c}_f\right) + p_d^* c_d + p_n c_n = m - p_f^* \overline{c}_f, \tag{4}$$

where $m - p_f^* \overline{c}_f$ is *surplus income* after an individual has purchased her subsistence requirement for food. Given the log-linear utility, the optimal choice for a consumer is for the expenditure share of surplus income on good j to equal its weight in the utility function, β_j. Given that urban non-tradables are by definition only produced domestically, total expenditure on them must equal the total value of production,

$$\beta_n\left(m - p_f^* \overline{c}_f\right) = p_n Y_n. \tag{5}$$

The two tradable goods can be produced domestically, imported from the rest of the world, or exported. In addition, the economy has the revenue from the natural resource, R, that can be used to pay for imports. Assuming balanced trade yields the following condition

$$\left(\beta_f + \beta_d\right)\left(m - p_f^* \overline{c}_f\right) + p_f^* \overline{c}_f = R + p_f^* Y_f + p_d^* Y_d. \tag{6}$$

Labor mobility between the sectors of the economy ensures the wage is equalized, or

$$(1-\alpha) p_j A_j L_j^{-\alpha} = (1-\alpha) p_k^* A_k L_k^{-\alpha} \tag{7}$$

for any sectors j and k. Given the balanced trade conditions in (5) and (6), the wage equalization in (7), the production funtions from (2), and the adding up constraint $L_f + L_d + L_n = 1$, we can solve for the following implicit function of the allocation of labor to the urban non-tradable sector,

$$L_n = \beta_n \left(1 + \frac{(1-L_n)^\alpha}{\overline{A}}\left(R - p_f^* \overline{c}_f\right)\right), \tag{8}$$

where $\overline{A} = [(p_d^* A_d)^{1/\alpha} + (p_f^* A_f)^{1/\alpha}]^\alpha$ is a composite measure of productivity in the two tradable sectors of the economy.

The size of the urban non-tradable sector depends primarily on income levels in the economy, as in (8). First, there is an income effect on the demand for urban non-tradables because of the subsistence requirement. If R rises, this serves unambiguously as an increase in income, and this increases the share of workers in urban non-tradables, as the additional revenue is spent disproportionately on non-food consumption, of which non-tradables are a fixed fraction. Second, an increase in productivity, $\overline{A}$, will also increase income. So long as $R < p_f^* \overline{c}_f$, this will cause a shift into urban non-tradable work. This happens because increasing tradable sector productivity allows fewer workers to meet the subsistence constraint (either working directly in the food sector or indirectly through exports of tradable goods).[6]

Given a solution for L_n, the allocation of labor to the other sectors is

$$L_d = (1 - L_n)\left(\frac{p_d^* A_d}{\overline{A}}\right)^{1/\alpha}$$
$$L_f = (1 - L_n)\left(\frac{p_f^* A_f}{\overline{A}}\right)^{1/\alpha} \tag{9}$$

which simply says that the allocation of labor to a tradable sector is a proportion of all tradable labor, and that proportion depends on the relative productivity of the sector.

2.2 Urbanization and comparative statics

Given the labor allocations, finding the urbanization rate, U, is straightforward; it equals the proportion of workers in the two urban sectors

$$U = L_n + L_d. \tag{10}$$

Given this definition, we can now examine how urbanization responds to different shocks, and this will show how natural resources will generate urbanization that involves a different composition of workers than shocks to tradable productivity.

Proposition 1 (Resources and consumption cities) *Given (8) and (9) it holds that:*

(A) $\partial U/\partial R > 0$
(B) $\partial L_n/\partial R > 0$
(C) $\partial L_d/\partial R < 0$

Proof The three partial relationships can all be established by taking derivatives in Eqs. (8) and (9) using the implicit function theorem. □

[6] Both results follow directly from Eq. (8) and applying the implicit function theorem. If $R > p_f^* \overline{c}_f$, then an increase in $\overline{A}$ will actually lower non-tradable labor. In this case, resource earnings are so high that the economy would already have a fraction greater than β_n in non-tradables. Any increase in tradable productivity would substitute workers away from that sector.

Increased resource revenues, as discussed above, lead to higher demand for urban non-tradables through income effects. Demand for tradable goods and food can be met using the increased revenue from R, and so labor can be shifted to non-tradable goods. While the number of tradable workers falls, this is more than made up for by the increase in urban non-tradable workers, and the urbanization rate rises.

Although the overall effect on urbanization is positive, note that resources have a distinct effect on the *composition* of urban labor. Resources cause a substitution away from tradable labor, and therefore the urban labor force becomes skewed towards non-tradable workers in response. This creates what we termed "consumption" cities, where urbanization is *not* associated with industrialization. We can compare this to an alternative route to urbanization.

Proposition 2 (Industrialization and production cities) *When $R < p^*_{rd}\overline{c}_{rd}$, then given (8) and (9) it holds that:*

(A) $\partial U/\partial p^*_d A_d > 0$
(B) $\partial L_n/\partial p^*_d A_d > 0$
(C) $\partial L_d/\partial p^*_d A_d > 0$

Proof The three partial relationships can all be established by taking derivatives in Eqs. (8) and (9) using the implicit function theorem. □

Increasing tradable sector productivity (either directly or through an increase in the world price) has two effects. First, it naturally causes a substitution across the two tradable good sectors—away from food production and into tradable production. Second, with $R < p^*_{rd}\overline{c}_{rd}$, the income effect of increased productivity in the tradable sector causes a shift towards urban non-tradable production, as workers are released from the tradable food sector through increasing productivity. The net effect on the employment composition of cities depends on the initial allocation, but compared to resource-led urbanization, industrialization generates "production cities" that have an expanding group of tradable sector workers combined with a population of urban non-tradable sector workers.

Propositions 1 and 2 provide some structure for the empirical work in the following sections. First, the effect of either increasing R or $p^*_d A_d$ holds taking the other as given. Thus, we will regress urbanization on both resource rents *and* the tradable sector's share in GDP (to control for $p^*_d A_d$). Thus we will be able to identify the partial effect of R or $p^*_d A_d$; the Propositions above imply that both of these terms should be positively related to urbanization rates.

Second, whether urbanization is driven by resources or by productivity in the tradable sector, the underlying relationship is due to income effects. In both cases, higher incomes lead to greater demand for non-tradable goods, and this in turn leads to a larger fraction of urban workers. In the empirical work, then, we should see that increased resource exports and increased tradable good production are both associated with higher income per capita. Further, holding constant income per capita, resource exports and tradable productivity are expected to have no additional effect on urbanization. Our regressions below are consistent with both predictions.

Finally, Proposition 1 shows that the source of urbanization matters for the composition of urban employment and population. Holding constant all other characteristics (including tradable sector productivity and income per capita) higher resource exports should be associated with a higher proportion of non-tradable workers in cities. As will be seen below, the data are consistent with this expectation.

3 Data and stylized facts

Examining the effect of natural resources on urbanization in developing countries is not straightforward, as data on both are not always readily available. For our analysis, we assembled data for 116 countries from 1960 to 2010.[7] We exclude from our study Europe and the Neo-Europes, as they were already highly urbanized in 1960. We focus on countries that belonged in the "developing world" in 1960. Of those developing countries, we exclude those that are smaller in area than 500 square kilometers (e.g. the Seychelles) and countries that do not have sufficient data over the entire period (e.g. North Korea, Central Asian ex-Communist countries). Full details of our criteria are available in the Web Data Appendix. The 116 countries we are left with belong to four areas, as defined by the World Bank: Asia (N = 27), Latin America and the Caribbean (LAC, N = 26), the Middle-East and North Africa (MENA, N = 17) and Sub-Saharan Africa (SSA, N = 46).

We use United Nations (2011) to obtain the urbanization rate (%) for the 116 countries for every ten years from 1960 to 2010.[8] For the purposes of our analysis, we define natural resource exports to consist of fuel, mineral, cash crop and forestry exports. We use World Bank (2013) and USGS (2013) to estimate the share of fuel and mineral exports in total merchandise exports (%) for each country-year observation. Two issues with the World Bank data set are that there are many missing observations and that the value of fuel and mineral exports is sometimes purposely underestimated in national accounts data, especially in more corrupt countries. We correct the World Bank data set using the very informative annual country reports of USGS (2013). This allows us to estimate the "true" contribution of such exports to these economies. We use FAO (2013) to obtain exports of cash crops and forestry for the same observations.[9] Using these data, we define countries with resource exports to GDP of more than 10 % as "resource exporters" (60 countries) and those with less than 10 % as "non-exporters" (56 countries).[11]

With these data in hand, we can look at several simple correlations. At first glance, resource-exporters and non-exporters do not appear to be significantly different in terms of the income/urbanization relationships. Figure 1 plots the urbanization rate in 2010 against log GDP per capita in 2010. As can be seen, there is a consistent positive relationship across both samples. In all cases, higher urbanization rates are associated with higher income per capita. But despite the apparent consistency in Fig. 1, there are distinct differences in the relationship of industrialization and urbanization between resource-exporters and non-exporters. Figure 2 plots the urbanization rate in 2010 against the share of manufacturing and services in GDP for 2010, a crude proxy of industrialization. For non-resource exporters (the black circles), the relationship of urbanization with manufacturing and services is clearly positive and quite consistent within the sample. Increasing urbanization is associated with increasing industrialization. But for resource-exporters (the gray squares), there is no meaningful rela-

[7] The list of countries is available in Web Appendix Table 1.

[8] We recognize that urbanization rates are not in fact collected in each year; the reported figures reflect interpolation and extrapolation from census data and other sources. Nevertheless, we believe that the data from United Nations (2011) offer a generally reliable picture of urbanization, given that population trends tend to be smooth and fairly predictable.

[9] Cash crops include tropical crops that cannot serve as the basis for subsistence and are produced for export: cocoa, coffee, cotton, groundnuts, rubber, sisal, sugar and tea.[10] We will show that our results are nonetheless robust to including *all* agricultural exports (i.e., including both cash and subsistence crops).

[11] The choice of cutoff level is arbitrary, but none of the analysis depends on this precise choice, and in the empirical work of the next section we treat resource exports as a percent of GDP, using the continuous variable instead of relying on a specific cutoff value.

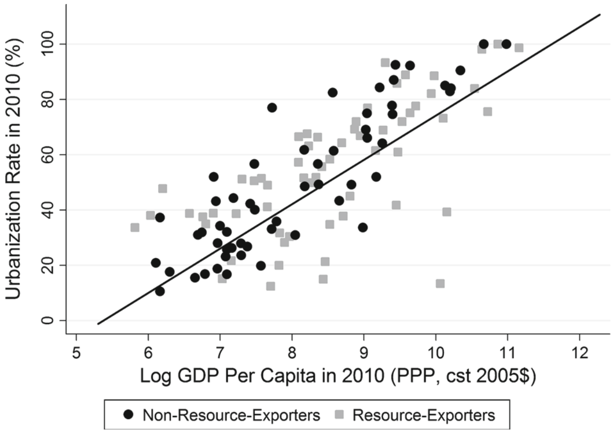

Fig. 1 Urbanization and income for entire sample of non-resource-exporting and resource-exporting countries. This figure shows the relationship between the urbanization rate (%) and log GDP per capita (PPP, constant 2005$) for 116 countries that were still developing countries in 1960, across four areas in 2010: Africa (N = 46), Asia (27), Latin American and the Caribbean (26) and Middle-East and North Africa (17). The sample is split into two groups, depending on the average share of natural resource exports in GDP in 1960–2010 (%). A country is a "non-resource exporter" if this share is below 10 % (56) and a "resource exporter" if this share is above 10 % (60). See Web Appendix for data sources

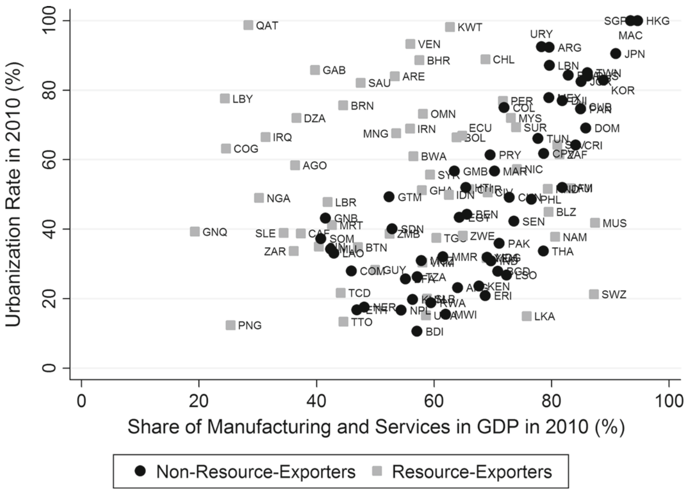

Fig. 2 Urbanization and manufacturing and services for entire sample of non-resource-exporting and resource-exporting countries. This figure shows the relationship between the urbanization rate (%) and the share of manufacturing and services in GDP (%) for the same 116 countries in 2010. The sample is split into the two groups of non-resource and resource exporters, depending on the average share of natural resource exports in GDP in 1960–2010 (%) (see the footnote of Fig. 1). See Web Appendix for data sources

tionship of urbanization with manufacturing and services in GDP. In general, these countries have much higher urbanization rates at any given level of manufacturing and services in GDP than non-exporting countries. They have urbanized without necessarily industrializing, and the suggestion of Fig. 2 is that natural resource exports may offer an explanation for this pattern.

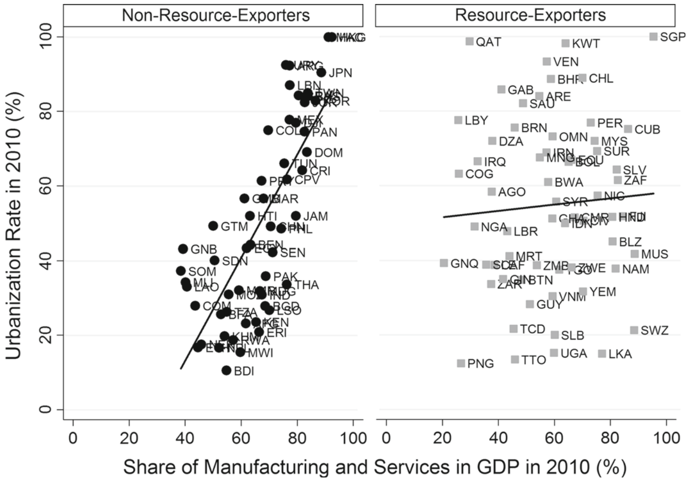

Fig. 3 Urbanization and manufacturing and services separately for non-resource-exporting and resource-exporting countries. This figure shows the relationship between the urbanization rate (%) and the share of manufacturing and services in GDP (%) separately for 56 non-resource-exporting countries and 60 resource-exporting countries in 2010 (see the footnote of Fig. 1). The *solid line* is a linear fit for the data. See Web Appendix for data sources

To this point, our definition of industrialization includes both manufacturing and all services. Reasonable alternatives would be to include only those services that are potentially tradable or to ignore services completely. It is not immediately obvious how to disaggregate services in a useful way.[12] But the general correlations hold if we plot urbanization against manufacturing plus FIRE ("finance, insurance, real estate and business services"), or if we plot urbanization against manufacturing alone.[13]

These differences can be seen more clearly in Fig. 3, in which we plot the relationship between urbanization and industrialization separately for resource exporters and non-exporters. Here we see that the non-exporters line up neatly with the typical intuition regarding urbanization and industrialization. In comparison, for resource exporters, there is no tendency for urbanization rates to be associated with industrialization. However, Fig. 4 shows that for these same countries, urbanization exhibits a strong positive correlation with their level of natural resource exports.[14]

It is useful to consider patterns within specific regions of the world, as they display the correlations more starkly. Latin America and the Caribbean (LAC) and the Middle

[12] There are arguably good reasons not to identify industrialization with manufacturing alone. Some service sector activities seem to have many of the characteristics of industry, and the GDP share of services rises with development (Herrendorf et al. 2011), even as manufacturing peaks and then declines. Second, industrializing countries may have a comparative advantage in the production of tradable services such as finance and business services (Jensen and Kletzer 2010). These services now account for a large share of GDP in countries such as Japan, which has clearly industrialized. This evolution of world output suggests that a sensible definition of industrialization might include certain parts of the service sector. But it has proven difficult to define the subset of services that might reasonably count as "industry," or to specify criteria that would usefully characterize this definition.

[13] See Web Appendix Figs. 1–4 for these results.

[14] These relationships are robust to the exclusion of outliers Bahrain (BRN), Kuwait (KWT), and Qatar (QAT), or giving less weight to smaller countries by using the population of each country in 2010 as weights for the estimation of the linear fit. See Web Appendix Figs. 5 and 6.

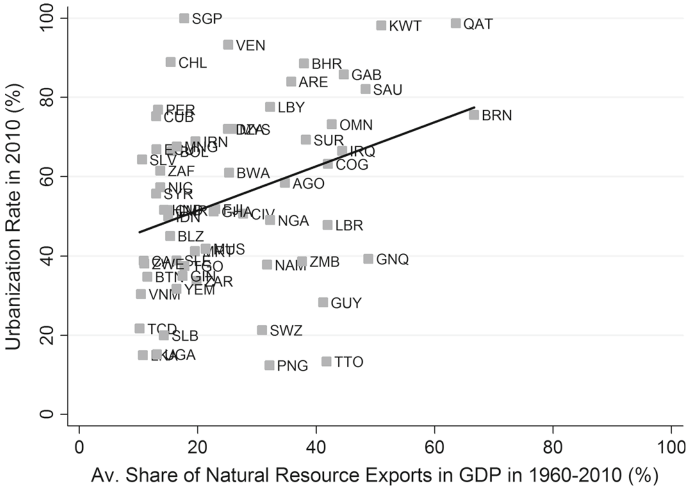

Fig. 4 Urbanization and natural resource exports for resource-exporting countries. This figure shows the relationship between the urbanization rate (%) in 2010 and the average share of natural resource exports in GDP (%) in 1960–2010 for 60 resource-exporting countries (see the footnote of Fig. 1). The *solid line* is a linear fit for the data. See Web Appendix for data sources

East and North Africa (MENA) are relatively more urbanized than Africa and Asia, with urbanization rates about 80 and 60 % in 2010 respectively. In both Africa and Asia, the urbanization rate was only 10 % in 1950, but it is now around 40 %, as high as in developed countries after the Industrial Revolution. Asia and the LAC region offer examples of urbanization *with* industrialization, as can be seen in the left-hand panels of Fig. 5, which display a clearly positive association of urbanization with the share of manufacturing and services in GDP. Exceptions include Mongolia and Venezuela, which heavily depend on resources.

In contrast, Africa and the Middle East offer many examples of urbanization *without* industrialization. Figure 5 shows in the right-hand panels that urbanization in these regions is positively associated with the importance of natural resource exports in GDP, but there appears to be no relationship of urbanization with the share of manufacturing and services in GDP. Sub-Saharan Africa is a particularly interesting example. Its manufacturing and service sectors are relatively small and unproductive (McMillan and Rodrik 2011; Jedwab and Osei 2013); in 2010, employment shares in industry and services were 5 and 29 % for Africa, but 15 and 35 % for Asia, and Asian labor productivity was 1.9 and 2.3 times higher in industry and services, respectively (World Bank 2013). However, Africa has urbanized to the same level as Asia over the last half-century. The most urbanized countries export natural resources: oil (e.g., Angola, Gabon and Nigeria), diamonds and/or gold (e.g., Botswana, Liberia and South Africa), copper (e.g., Zambia) or cocoa (e.g., Ivory Coast).

An important point to make is that urbanization in resource exporters is not driven by meaningful shifts of labor into urban areas to work in the resource sector. Mineral resources are highly capital-intensive, and their production creates very little direct employment. Angola's urbanization rate was 15 % before oil was discovered in the 1960's, but it was 60 % in 2010. The country now has an urban population estimated at 11 million people. But although oil accounts for over 50 % of GDP, this sector employs only about 10,000 workers. Botswana has a similar urbanization rate to Angola, and while the diamond sector accounts for 36 % of

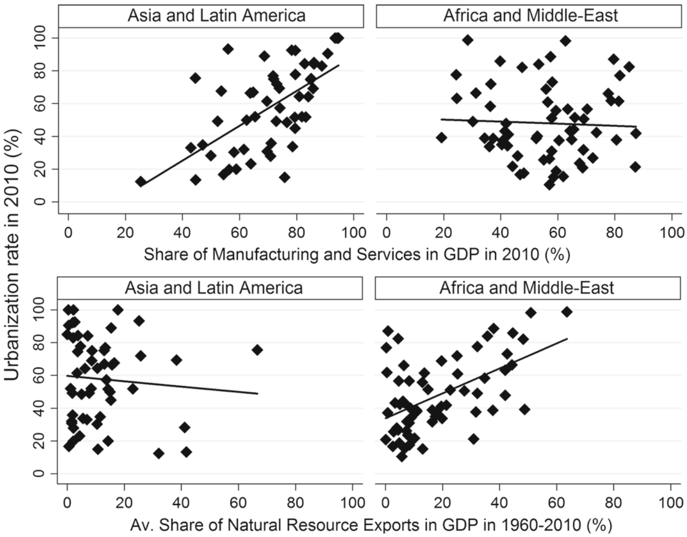

Fig. 5 Urbanization, manufacturing, services and natural resource exports in Asia and Latin America versus Africa and the Middle-East. This figure shows the relationships between the urbanization rate (%) and the share of manufacturing and services in GDP (%) or the average share of natural resource exports in GDP (%) in 1960–2010 separately for 53 countries in Asia (N = 27) and Latin America and the Caribbean (26), and 63 countries in Africa (46) and the Middle-East and North Africa (17). The *solid line* is a linear fit for the data. See Web Appendix for data sources

GDP, it only provides employment for 13,000 people. Oil exports account for 50 % of GDP in Saudi Arabia, one of the most urbanized countries in our sample, yet the mining sector only employs 1.5 % of its urban workforce.[15] Mining accounts for 1 % of total urban employment on average in our sample of resource exporters. Minerals and other "point source" resources do not directly drive urbanization. Neither is urbanization driven by direct employment in the production of cash crops or forest products. These are generally produced in rural areas and mostly contribute to *rural* employment.

While it is too crude to simply equate urbanization with non-agricultural work, nonetheless there is a strong correlation between the two. Using the most recent data available between 2000–2010 for 42–83 countries, we find that 91 % of agricultural employment is in rural areas while 67 % of non-agricultural employment is in urban areas. Rural areas have about 30 % of their employment in non-agricultural activity, but in urban areas this is 92 %. Overall, neither mineral nor cash crop employment is capable of explaining the correlation of resource exports and urbanization.[16]

We thus have *prima facie* evidence that resource exports drive urbanization, but not through direct employment effects. In the following sections we will first demonstrate empirically that the positive effects of resources on urbanization are in fact a robust feature of the data, and additionally that resource-led urbanization generates different types of cities than more traditional industrial-led urbanization.

[15] All data on workers refers to domestic nationals; expatriates are excluded.

[16] See Web Appendix Table 2 for a full breakdown of employment across sectors and locations. We note that in the data, "rural" and "urban" may be defined by administrative boundaries that are imprecise. Some of the rural non-agricultural employment may take place in towns that are misclassified as rural.

4 Estimation of effect of resources on urbanization

We want to establish that the correlations seen in the prior section are robust to confounding factors—and whether they reflect an underlying causal relationship. As established in the model, resources should have a significant effect on urbanization, holding constant the productivity of the tradable sector. To establish this, we take three different empirical approaches. The first consists of cross-sectional estimates of the effect of resources on urbanization in 2010 that include a number of possible control variables. Second, we use panel estimates to show that *within* countries, changes in resource exports are significantly associated with urbanization. Finally, we employ an instrumental variable specification using resource discoveries and price shocks to investigate the causal effect of resources. In each case, the estimated relationship of resource exports with urbanization is statistically significant and economically large.

The sample for the regressions is the same one described in the prior section. In addition to the data on urbanization, resources exports, and share of manufacturing and services, we will use a range of control variables from standard sources at the country level that are described in detail below. Summary statistics are available in Web Appendix Table 3.

4.1 Cross-sectional estimates

Our first approach is a simple cross-section, denoted

$$U_{c,2010} = \alpha + \beta R_{c,1960--2010} + \gamma I_{c,2010} + \delta X_{2010} + u_{c,2010}. \tag{11}$$

Here the urbanization rate in 2010 is the dependent variable ($U_{c,2010}$), regressed on the average share of natural resource exports in GDP in 1960–2010 ($R_{c,1960-2010}$) as well as the share of manufacturing and services in GDP (i.e. industry) in 2010 ($I_{c,2010}$).[17] Additional controls are included in the vector X_{2010} and will be explained in detail below as we discuss the results. This cross-sectional regression (and the specifications that follow) is intended to show that resources have an independent effect on urbanization, even controlling for the level of industrialization

Table 1 shows the results, with columns reflecting specifications that include different combinations of control variables. All regressions are population weighted. Column (1) includes only the measure of manufacturing and services in GDP as a control. Here, resource exports have a positive and significant effect on urbanization. The size of this effect drops in column (2), which adds in fixed effects for the main World Bank areas: Asia, LAC, SSA, and MENA. This controls for level differences in urbanization between these areas. However, even within these areas, the effect of resource exports on urbanization remains significant and relatively large in size.

Column (3) incorporates a series of time-invariant controls. First, land pressure and man-made or natural disasters may result in a lower rural wage, with rural migrants flocking to the cities. We include the following controls at the country level, to account for different kinds of pressures and disasters: rural density in 2010 (1000s of rural population per sq km

[17] While the share of manufacturing and services in GDP in 2010 is a good proxy for the extent of industrialization in 1960–2010, the share of resource exports in GDP in 2010 does not measure well the historical dependence on resource exports. First, many countries have relatively recently started exporting oil, such as Equatorial Guinea and Yemen. For these countries, the historical share of resource exports in GDP does not explain well the contemporaneous urbanization rate. Second, a few countries that were previously resource exporters have become more industrialized over time (e.g., Chile and Malaysia). Lastly, the contribution of resource exports to GDP depends on international commodity prices, which are volatile in the short run. Using the mean share of resource exports in 1960–2010 minimizes these concerns.

Table 1 Multivariate cross-sectional analysis, main stylized fact

Dependent variable	Urbanization rate in 2010 (%)				
	(1)	(2)	(3)	(4)	(5)
Natural resource exports	1.77***	1.32***	0.99***	1.02***	0.85**
(% of GDP, Average in 1960–2010)	(0.28)	(0.22)	(0.14)	(0.24)	(0.18)
Manufacturing & services	1.38***	1.03***	0.59***	0.46**	0.38***
(% of GDP, in 2010)	(0.22)	(0.27)	(0.14)	(0.17)	(0.12)
Area FE (4)	N	Y	Y	Y	Y
Time-invariant controls	N	N	Y	Y	Y
Control for initial conditions 1960	N	N	N	Y	Y
Region FE (13)	N	N	N	N	Y
Observations	116	116	116	116	116
R-squared	0.48	0.63	0.85	0.92	0.95

Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 116 countries that were still developing countries in 1960, across four areas: Africa (N = 46), Asia (27), Latin America and the Caribbean (26) and Middle-East and North Africa (17). All regressions are population-weighted. Columns (2)–(5) include area fixed effects. Columns (3)–(5) include the following controls: (i) Urban definition: four dummies for each type of definition (*administrative*, *threshold*, *threshold and administrative*, and *threshold plus condition*) and the value of the population threshold to define a locality as urban when this definition is used; (ii) Rural push factors: rural density (1000s of rural population per sq km of arable area) in 2010, population growth in 1960–2010 (%), the number of droughts (per sq km) since 1960 and a dummy equal to one if the country has experienced a conflict since 1960; (iii) Urban pull factors: a dummy equal to one if the country was mostly autocratic since 1960 and the primacy rate (%) in 2010; and (iv) Other controls: area (sq km), population (1000s), a dummy equal to one if the country is a small island (<50,000 sq km) and a dummy equal to one if the country is landlocked. Column (4) also controls for initial conditions, i.e. the urbanization rate (%) and the share of natural resource exports in GDP (%) in 1960. Column (5) also include thirteen region fixed effects (e.g., Western Africa, Eastern Africa, Central Africa, Southern Africa, etc.). See Web Appendix for data sources and construction of variables

of arable area) and the annual population growth rate in 1960–2010 (%) to control for land pressure, the number of droughts (per sq km) since 1960, and an indicator equal to one if the country has experienced a civil or interstate conflict since 1960 to control for disasters.[18] Second, urban-biased policies may result in a higher urban wage. We include an indicator equal to one if the country's average combined polity score since 1960 is strictly lower than −5 (the country is then considered as autocratic according to *Polity IV*), as the urban bias was stronger in more autocratic regimes, as shown by Ades and Glaeser (1995). We also add the primacy rate (%) in 2010, as an alternative measure of the urban bias.[19] Third, if resource exporters systematically use different methods for calculating urbanization rates, the correlations may simply reflect measurement errors. We handle this issue by adding controls for the different possible definition of cities in different countries: four indicators for each type of urban definition used by the countries of our sample (*administrative*, *threshold*, *threshold and administrative*, and *threshold plus condition*) and the value of the population

[18] Rapid population growth and land pressure could drive urban growth if the rural wage decreases. However, excess urban population growth could also decrease the urban wage. Ultimately, the urbanization rate only increases if urban growth is faster than rural growth, which is not obvious here. For example, we do not find any correlation between demographic growth and urbanization in the data. We nonetheless control for rural density and demographic growth in the regressions.

[19] Urban primacy is defined as the percent of urban population living in the largest city.

threshold that defines a locality as urban, when this type of definition is used. Lastly, we also control for country area (sq km), country population (1000s), a dummy equal to one if the country is a small island (<50,000 sq km) and a dummy equal to one if the country is landlocked, as larger, non-island and landlocked countries could be relatively less urbanized for various reasons.

As can be seen in column (3), the inclusion of these controls does not alter the positive association of resource exports with urbanization rates. This is statistically significant and very strong. A one standard deviation increase in the share of resource exports in GDP (roughly 15 % points) is associated with a 0.60 standard deviation increase in the urbanization rate, equivalent to a 15 % point increase. It seems fair to label this an economically meaningful change. To address the possibility that the regressions in columns (1) through (3) are still picking up an unobserved effect driving both resource exports and urbanization, in column (4) we also control for initial conditions in 1960. Specifically, we include the level of urbanization in 1960 (%) and the share of natural resource exports in GDP in 1960 (%). Thus column (4) is essentially looking at a long-differenced relationship of the change in resource exports and the change in urbanization. As can be seen, results are not altered. Lastly, in column (5) we also include fixed effects for thirteen regions defined by the World Bank (e.g., Western Africa, Central Africa, Eastern Africa and Southern Africa for Africa) which effectively compares neighboring countries of the same region. The point estimates remain high and significant. A one standard deviation in resource exports is then associated with a 0.51 standard deviation increase in urbanization.[20]

Table 2 continues the cross-sectional analysis, incorporating further robustness checks and definitional issues. All regressions in Table 2 have the full set of controls used in column (5) in Table 1, including manufacturing and services as a percent of GDP in 2010. Column (A.1) simply replicates the result from Table 1 for comparison purposes.

In Panel A, we verify that the main cross-sectional correlation is robust to a set of additional controls. We begin in column (A.2) by controlling for a further set of geographic and political factors: (i) forested area (sq km); (ii) two dummies equal to one if the country has a large desert or is a city-state (to control for the fact that forest, desert and city-state countries could be more urbanized); (iii) a dummy equal to one if the country is a communist or former communist country (to control for the fact that such countries could be less urbanized due to internal migration restrictions, or alternatively, more urbanized due to state planning decisions); (iv) the share of government expenditures in GDP in 2010 (to better control for urban-biased policies); and (v) eight dummies equal to one if the country has been colonized by Belgium, England, France, Germany, Italy, the Netherlands, Portugal or Spain, respectively, to control for the possibility that the identity of the colonizer may have durably influenced urbanization.[21] Next we check for robustness to dropping countries with a population above 100 million (column A.3). We then drop population weights from the regressions (column A.4). Finally, we restrict the sample to Africa and the MENA region or Asia and the LAC region (columns A.5–A.6). The correlation of resource exports with urbanization is not significantly different across groups. Overall, the effect of resources remains statistically significant and practically large.

In Panel B of Table 2, we address the means of measuring natural resource exports. The columns use different definitions of resource exports. Column (B.1) uses the share of

[20] Estimated effects of each of the control variables used in Table 1, column (5) are available in Web Appendix Table 4. Alternative regional groupings provide similar results (see Web Appendix Table 5).

[21] Further robustness checks include (i) controlling for or omitting desert countries (see Web Appendix Table 6), (ii) excluding the outliers Bahrain, Kuwait, and Qatar (see Web Appendix Table 7), and (iii) using measures for government spending in 1960, 2010, or both (see Web Appendix Table 8).

Table 2 Multivariate cross-sectional analysis, robustness

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: robustness checks						
(Full Specification:	Baseline	More	No big	No pop.	Africa	Asia
Column (5) of Table 1)	Results	Controls	Countries	Weights	MENA	LAC
Natural resource exports	0.85***	0.72***	0.67***	0.61***	0.71***	1.14**
(% GDP, Av. 1960–2010)	(0.18)	(0.21)	(0.15)	(0.17)	(0.16)	(0.51)
Panel B: definitional issues						
(Full specification:	Nat. res.	Fuel &	Incl. all	Nat. res.	Ctrl.	Log value
Column (5) of Table 1)	Exp. 2010	Min. Exp.	Ag. Exp.	Exp. Rents	Mfg. Exp.	Per cap.
Natural resource exports	0.36***	0.77***	0.53**	0.54***	0.85***	2.50***
(Various measures)	(0.12)	(0.18)	(0.21)	(0.17)	(0.18)	(1.21)
Panel C: heterogenous effects						
(Full specification:	Oil-	Diamond	Gold-	Other	Cocoa-	Other
Column (5) of Table 1)	Gas		Copper	Mining	Forestry	Nat.Res.
Natural resource exports	0.89***	0.54**	0.38***	0.25	0.41**	−0.32
(% GDP, Av. 1960–2010)	(0.14)	(0.24)	(0.13)	(0.24)	(0.19)	(0.31)

Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample and the specification are the same as in column (5) of Table 1. A.(2): We add the following controls: forest area (in sq km), the share of government expenditure in GDP (%) in 2010, and eleven dummies equal to one if the country has a large desert, is a city-state, is a communist or former communist country, and was previously colonized by Belgium, England, France, Germany, Italy, the Netherlands, Portugal or Spain. A.(3): we drop the countries with a population over 100 millions. A.(4): regressions are not population-weighted. A.(5)–A.(6): we restrict the sample to Africa and MENA countries (N = 63) and Asian and LAC countries (53) respectively. B.(1): the variable of interest is the share of resource exports in GDP in 2010 (%) instead of the average share in 1960–2010. B.(2): it is the share of fuel and mining exports in GDP (%) in 1960–2010. B.(3): it includes the contribution of all agricultural exports (not just the contribution of cash crop exports) in 1960–2010. B.(4): it is the average share of resource rents in GDP (%) in 1970–2010. B.(5): we also add the average share of manufacturing exports in GDP (%) in 1960–2010. B.(6): the variable of interest is the average log value of resource exports in 1960–2010 (cst. 2005 PPP USD). C.(1)–(6): we interact the average share of resource exports in GDP (%) in 1960–2010 with dummies whose value is one if commodity X = [oil and gas, diamond, gold and copper, other mining, cocoa and forestry, other] is the country's main resource export in 1960–2010, for resource-exporters only. See Web Appendix for data sources and construction of variables resource exports in GDP (%) in 2010 instead of the average share in 1960–2010. Column (B.2) only considers the average share of fuel and mineral exports in GDP (%) in 1960–2010 instead of the average share of all resource exports (since the latter variable includes cash crop and forestry exports) in 1960–2010. In column (B.3) we include all agricultural exports (i.e., both subsistence crops and cash crops) when estimating the average share of resource exports (%) in 1960–2010. For column (B.4) we use the average share of natural resources rents (i.e., the sum of oil, gas and coal rents, mineral rents, and forest rents) in GDP (%) in 1970-2010, as rents take into account production costs and thus measure the added value of the resource sector.[22] In column (B.5) we control for the average share of manufacturing exports in GDP in 1960–2010 (%) as a proxy for industrialization, instead of using the share of manufacturing and services in GDP in 2010. Finally, in column (B.6) we use the average log value of resource exports per capita in 1960–2010 and the log value of manufacturing and service GDP in 2010 per capita instead of the GDP shares. As before, the effect of resources remains significant and economically meaningful.

The final robustness checks in the cross-sectional specifications evaluate the heterogeneous effect of different resources. We expect stronger effects for mineral resources, as their international supply is relatively inelastic and their production process is not labor-intensive (which should lead to higher income effects per capita), in contrast to cash crops. We split resource exports into fuel and mining exports versus cash crop and forestry exports (i.e., their average shares in GDP from 1960–2010). In the first five columns of Panel C in Table 2, we interact the average share of resource exports in GDP in 1960–2010 (%) with a dummy equal to one if commodity X = [oil-gas, diamond, gold-copper, other mineral product, cocoa-forestry] is the country's main primary export in 1960–2010. The correlations are stronger for oil and gas (column C.1) than for other mineral resources, such as diamonds, gold or copper. Regarding cash crops, the correlation is only significant for cocoa and forestry (column C.5), while a negative but not significant effect is found for other crops (column C.6).[23] While oil and gas have the strongest estimated effect, the overall relationship we found in Table 1 is not driven solely by oil producers.

4.2 Panel estimates

Despite the control variables we included, there is still the possibility that an unobserved factor is driving both resource exports and urbanization. To address the potential that an unobserved country characteristic is generating a spurious result, we turn to panel estimates. The basic estimation equation is now:

$$U_{c,t} = \alpha + \beta R_{c,t-1} + \gamma I_{c,2010} \times t + \kappa M_{c,t-1} + \theta_c + \lambda_t + u_{c,t}. \quad (12)$$

[22] Data on resources rents as a share of GDP (%) comes from World Bank (2013). Commodity-specific rents are estimated as the number of units produced times the difference between the world price of the commodity and average unit costs of extraction. Rather unfortunately, data is missing for the 1960s and for many country-year observations post-1970. Besides, production costs are not country-specific in the data, so country-specific rents are imperfectly measured. Our main variable of interest is the contribution of resource exports to GDP. We do not subtract the production costs of natural resources since they directly contribute to the economy by providing an external source of extra income to the domestic factors of production.

[23] These (non-)results on cash crops are in line with Jedwab (2013), who finds a positive effect of cocoa production on urban growth in Ghana and Ivory Coast, and Brückner (2012) and Henderson et al. (2013b) who find a negative effect of agricultural exports on urbanization in Africa when using agricultural price shocks as a source of identification. Positive price shocks should deter urbanization if workers are disproportionately drawn into the agricultural sector. Our empirical results suggest that the specialization effect indeed dominates the income effect for most cash crops.

We observe each variable in 6 periods (t = 1960, 1970, 1980, 1990, 2000, or 2010). We estimate the relationship of resource exports at time $t-1$ ($R_{c,t-1}$) with urbanization in period t ($U_{c,t}$). Country fixed effects (θ_c) capture the unobserved but time-invariant country characteristics, while time fixed effects (λ_t) account for any period-specific changes in urbanization across the sample.

As a time-varying control for industrialization, we include the share of manufacturing and services in GDP in 2010 ($I_{c,2010}$) interacted with t. We use this structure because actual data on the share of manufacturing and services in GDP is sparse for many of our countries in the early periods of our panel, and we do not wish to lose observations. What this implies is that we are assuming the cross-sectional variation in manufacturing and services in GDP is similar in each period, but the actual effect of this on urbanization changes over time.[24] To capture country and time-specific variation in manufacturing activity we include manufacturing exports as a percent of GDP ($M_{c,t-1}$) as an additional control. This term will pick up some of the variation year to year in country-level manufacturing activity.

Table 3 provides the results obtained when we estimate this relationship for our sample. In all regressions standard errors are clustered at the country level. Column (1) shows the unconditional results, which point to a similar and significantly positive impact of resource exports on urbanization rates in this sample. The remaining columns of Table 3 provide further control variables. In column (2) we incorporate area-time fixed effects, thus allowing for sub-Saharan Africa, for example, to have a different time trend in urbanization than other areas. Column (3) includes all of the control variables used in the cross-sectional analysis except they are now all time-varying and estimated at time t-1 (see the notes below Table 3 for a list of these controls). Column (4) controls for initial conditions (urbanization and resource exports in 1960) interacted with a time trend, so that these conditions have an evolving effect over the panel. Finally, column (5) incorporates region-year fixed effects. These regions, recall, are groupings smaller than the main areas used in column (2), and as such there are 65 region-year fixed effects estimated.[25]

Regardless of controls, the relationship of resource exports to urbanization is positive and statistically significant in these panel estimates. However, the estimated coefficient is smaller relative to the cross-section. A one standard deviation increase in resource exports is associated with a 0.10 standard deviation increase in urbanization. This correlation is approximately one-fifth the size of the coefficient from the cross-sectional analysis. Several explanations are possible. First, the country-level fixed effect in the panel regression may be picking up an omitted variable that drives both resource exports and urbanization. Second, the differences in resource exports over time may suffer from measurement error, leading to attenuation bias in the panel regressions. Last, the panel regressions estimate the short-term effects (i.e. over a ten-year period) of variations in resource exports on urbanization. As cities take time to build and migration takes time to occur, it is perhaps not surprising that the effect of a resource boom in time t has a relatively small effect ten years later. In contrast, the cross-sectional regressions measure the long-term effects of resource exports. The cross-sectional effect of resources on urbanization would thus be larger, as it is the accumulated effect of the various short-term effects. In the following section, we will pursue an identification strategy

[24] The results hold when controlling for the share of manufacturing and services in GDP at period t ($I_{c,t}$) for the restricted sample of non-missing observations (see Web Appendix Table 9).

[25] In addition to these results, the panel estimates are robust to (i) different definitions of areas and/or regions (Web Appendix Table 10), (ii) controls for or omitting desert countries (Web Appendix Table 11), (iii) excluding outliers Bahrain, Kuwait, and Qatar (Web Appendix Table 12), and (iv) using government expenditures in 1960, 2010, or both as controls (Web Appendix Table 13).

Table 3 Multivariate panel analysis, main stylized fact

Dependent variable	Urbanization rate in year t (%)				
	(1)	(2)	(3)	(4)	(5)
Natural resource exports	0.16**	0.17**	0.14*	0.18***	0.15**
(% of GDP, in year t-1)	(0.07)	(0.08)	(0.07)	(0.06)	(0.06)
Manuf. & serv. in 2010 × time trend t	0.02	0.02	−0.01	0.03	0.02
(% of GDP)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Manufacturing exports	0.35*	0.35	0.27*	0.23	0.08
(% of GDP, in year $t-1$)	(0.21)	(0.23)	(0.15)	(0.15)	(0.11)
Country and year FE (112; 5)	Y	Y	Y	Y	Y
Area-year FE (4 x 5)	N	Y	Y	Y	Y
Time-varying controls	N	N	Y	Y	Y
Initial conditions 1960×time trend t	N	N	N	Y	Y
Region-year FE (13 × 5)	N	N	N	N	Y
Observations (112 × 5)	560	560	560	560	560
Adj. R-squared	0.95	0.95	0.96	0.97	0.98

Robust SEs clustered at the country level in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 112 countries that were still developing countries in 1960, for the following years: [1960, 1970, 1980, 1990, 2000, 2010]. The share of resource exports in GDP (%) is estimated in year $t-1$, so we lose one round of data. The share of manufacturing and services in GDP (%) is only available for the year 2010, so we interact it with a time trend t. We include the share of manufacturing exports in GDP (%) in year $t-1$ to control for industrial booms. All regressions are population-weighted. Columns (2)–(5) include area-year fixed effects. Columns (3)–(5) include the following time-varying controls: (i) Rural push factors: rural density (1000s of rural population per sq km of arable area) in year $t-1$, population growth (%) between $t-1$ and t, the number of droughts (per sq km) between $t-1$ and t and a dummy equal to one if the country has experienced a conflict between t-1 and t; (ii) Urban pull factors: a dummy equal to one if the country was mostly autocratic in the previous decade (e.g., 1960–1969 for the year 1970) and the primacy rate (%) in year $t-1$; and (iii) Other control: population (1000s) in year t. Column (4) also controls for initial conditions, i.e. the urbanization rate (%) and the share of resource exports in GDP (%) in 1960, times a time trend t. Column (5) also include region-year fixed effects (e.g., Western Africa, etc.). See Web Appendix for data sources and construction of variables

using instrumental variables that can provide clues to the source of the difference between the cross-sectional and panel results.

4.3 Investigating causality

Even with these robustness checks, the correlations that we observe might still reflect remaining unobserved country-year variables that are driving the relationship between resource exports and urbanization. Alternatively, there may be measurement error in resource exports, or resource exports could be endogenous to the urbanization process.[26] We use various

[26] Urbanized countries could have fewer resources (e.g., land or labor) available for resource production. This would lead to a downward bias. It could also be the case that industrial countries do not export the natural resources they produce, using them instead as intermediate goods or consumption goods. For example, China and Mexico are among the world's top oil producers, but domestic demand accounts for large fractions of production. As these countries are also more urbanized, this leads to a downward bias. From the other side, investments in domestic transportation infrastructure both facilitate the exploitation of natural resources and

strategies to further investigate the causality of the relationship between resource exports and urbanization.

Table 4 shows the results of this analysis, which is built on the same panel structure of the prior section. Column (1) replicates the panel results of Table 3, column (5), for comparison purposes; this specification includes region-year fixed effects and all other time-varying controls. In column (2), we regress resource exports in time t on resource exports in time $t-1$, and find no significant effect. This shows the unpredictable nature of resource exports as a percent of GDP, and given the persistent nature of urbanization rates, makes it unlikely that urbanization could be driving these fluctuations.[27] Column (3) regresses resource exports at time t on urbanization rates in time $t-1$, finding no significant relationship. Again, this suggests there is no evidence that changes in urbanization lead to subsequent changes in resource exports. Column (4) looks at the contemporaneous effect of resource exports in time t on urbanization in time t. As can be seen, there is no significant relationship. Given our prior results show that resource exports in $t-1$ have a strong relationship to urbanization in t, this suggests that resources lead to urbanization, and not the other way around.

The results in columns (2)–(4) are suggestive, but to try and estimate the causal effect more formally we use resource discoveries and commodity price shocks as instruments, following (Sachs and Warner, 2001; Brückner, 2012; Henderson et al., 2013b). The instrument for discoveries is a dummy variable. For each country, we create a post-discovery indicator whose value is one if the country's chief natural resource in 1960–2010 has already been "discovered" at period t-1. Countries that had already discovered their chief resource in 1960 (e.g. Saudi Arabia) thus are coded with a 1 for each period in 1960–2010. Countries that have never discovered a resource (e.g. Taiwan) have a 0 for each period. The information on discoveries is drawn from USGS (2013) surveys from the associated years, and we use the first year that the resource is mentioned for a country in those surveys to establish the year of discovery.[28] Using this instrument, the effect of resource exports is identified from the countries for which a discovery occurred post-1960, and thus the indicator flips from 0 to 1 during our panel. Figure 6 shows five examples from our sample: Angola (oil; 1968), Botswana (diamonds; 1968), Gabon (oil; 1963), Libya (oil; 1960) and Oman (oil; 1964). These countries each experienced a resource discovery, and their urbanization rates then rose relative to countries in their respective areas (Africa or MENA). The regressions we run will confirm that the pattern seen from those five countries in Fig. 6 is statistically significant and robust to the inclusion of the entire range of control variables we consider.

The second instrument we consider is a price index of the main resource for each country that is a resource exporter. Fluctuations in world prices for commodities will generate fluctuations in the value of resource exports. Zambia offers an example of how this shock works in practice (see Fig. 6). The slump in copper prices in 1975 led to "counter-urbanization" in Zambia (Potts 2005), but appreciation in copper prices has also led to higher urbanization rates more recently. The value of using price discoveries as an instrument is that they provide both positive and negative shocks to resource exports, as opposed to discoveries which provide only positive shocks.

promote urbanization, leading to an upward bias. Poor institutions that foster an urban bias and restrict industry could also lead to high resource exports as well as high urbanization.

[27] While resource exports fluctuate as a percent of GDP, the binary status of being a resource exporter is highly persistent. In our sample, once a country discovers a resource that is exported,it continues to export that resource in some capacity throughout the period of study. Web Appendix Fig. 7 shows the the fluctuations in resource exports in GDP for 12 countries.

[28] Details of our coding process are available in the Web Appendix, as well as examples of how we coded the discoveries in Botswana (diamonds) and Oman (oil) in Web Appendix Figs. 8 and 9.

Table 4 Multivariate panel analysis, investigation of causality

Dependent variable	Urbanization rate in year t (%)					
	(1)	(2)	(3)	(4)	(5)	(6)
(Full specification: Column (5) of Table 3)	Baseline results	Dep. variable: nat. res. exp.(t)		Placebo test	IV: All Countries	IV: Only exporters
Natural resource exports	0.15**	0.06		−0.01	0.39***	0.30**
(% GDP, year $t-1$, but t in (4))	(0.06)	(0.08)		(0.06)	(0.14)	(0.15)
Urbanization rate			−0.00			
(%, in year $t-1$)			(0.10)			
1st Stage:						
Post-discovery indicator (in Year $t-1$)					24.5***	32.1***
					(4.6)	(6.5)
Main commodity price index (base period = 2000, in Year $t-1$)					0.05***	0.03
					(0.02)	(0.03)
Kleibergen-Paap rk Wald F stat					19.2	12.9
Observations (112|60x5)	560	560	560	560	560	300

Robust SEs clustered at the country level in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample and the specification are the same as in column (5) of Table 3. In columns (2) and (3), the dependent variable is the share of natural resource exports in GDP (%) in year t (instead of the urbanization rate in year t). In column (3), the main variable of interest is the urbanization rate in year $t-1$. In column (4), the variable of interest is the share of natural resource exports in GDP (%) in year t. In columns (5) and (6), we use two instruments for the share of natural resource exports in GDP (%) in year $t-1$: a post-discovery indicator whose value is one in year $t-1$ if the country's main commodity was already "discovered" then, and the world price index of the country's main commodity (base period = 2000) in year $t-1$. In column (6), we restrict the sample to resource-exporters only (N = 300). See Web Appendix for data sources and construction of variables

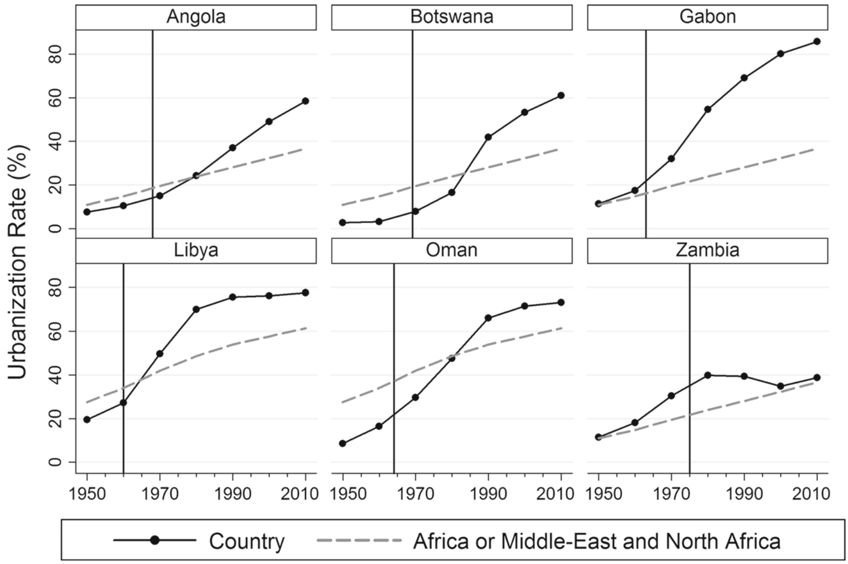

Fig. 6 Urbanization and resource discovery for six resource-exporting countries, 1950–2010 *Notes:* This figure shows the evolution of the urbanization rates for six resource exporters and their respective area ("Africa" or "Middle-East and North Africa") from 1950–2010. For all countries except Zambia, the solid line indicates the main year of discovery of the country's chief primary export: Angola (oil; 1968), Botswana (diamonds; 1968), Gabon (oil; 1963), Libya (oil; 1960) and Oman (oil; 1964). For Zambia, the *solid line* indicates the year of the slump in copper prices (1975), the country's chief primary export. See Web Appendix for data sources

Columns (5) and (6) of Table 4 show results of IV regressions where both the discovery indicator and price index are used as the instruments for resource exports. These regressions use panels, and again include all of the region-year fixed effects and time-varying controls considered in Table 3. Column (5) shows the results for the full sample of countries, and the effect of resource exports is significant, positive, and larger in absolute value than the simple panel estimates. We can also limit the sample to countries that have any resource exports during the period, and the results hold in column (6).

Comparing the IV results in column (5) with the baseline panel results in column (1), the estimated effect of resource exports on urbanization is larger in the IV (0.39 versus 0.15). Note that the IV estimate is still smaller in absolute value than the cross-sectional results in Table 1; however, it is much larger than the standard panel results. In light of the discussion at the end of the prior section, this indicates that while there may be some time-invariant characteristics of countries that drive both resources and urbanization, the effect of this characteristic is not nearly as large as suspected in the baseline panel results. The larger coefficient in the IV regressions may also indicate that the normal panel results were subject to measurement error in resource exports. Finally, the fact that the panel IV results continue to be smaller than the cross-sectional estimate is consistent with the panel picking up short-run effects of resources on urbanization, while the cross-section captures long-run effects.

5 Consequences of resource-led urbanization

Resource exports are tightly associated with urbanization, but an open question is whether this resource-led urbanization differs from urbanization driven by more traditional "agricultural push" or "industrial pull" factors. To begin, we first establish that the general process of urbanization is always tied to income per capita, regardless of the original push. This is what we established in the model, and it can be seen in Fig. 1, where resource exporters have the same relationship as non-exporters between income per capita and urbanization. Table 5 presents cross-sectional regressions using our sample, showing that this is a robust feature of the data. Column (1) shows that average output per capita between 1960–2010 is positively correlated with greater resource exports, holding constant manufacturing and services in GDP, and including all the controls and region fixed effects found in Table 1. Column (2) of the table, for comparison purposes, shows a similar pattern of results to those established in the prior section; namely, resource exports are significantly associated with urbanization in 2010. In column (3) we control for average GDP per capita in 1960–2010, in addition to the other controls. Here, once we have accounted for income per capita, the independent effects of resource exports and manufacturing and services both become insignificant. Columns (2) and (3) show us that resource exports drive urbanization through an income effect—exactly in the same way as manufacturing and services. *Any* increase in income is associated with higher urbanization, it does not matter if that income comes from resources or from industrialization.

These relationships inform the remainder of the empirical work. From this point forward, our general strategy will be to use our basic cross-sectional specification to examine the effect of resource exports on different dependent variables, but now *controlling* for the urbanization rate and income per capita. We will thus be estimating the effect of resource exporting on the characteristics of cities created by the urbanization that resources bring. As established in the model, resources should differentially impact the composition of cities, conditional on tradable sector productivity and the level of income per capita.

The regressions that follow all include the full set of controls used in the cross-sectional results in Table 1, column (5). In each case, we report the results using both area fixed effects (4) and region fixed effects (13). As the data sources we use to derive the dependent variables vary in their coverage, the sample sizes vary across regressions. We will mention important sources of the data in the text that follows, but in each case full details are available in the Web Appendix. As at times the sample size will dip because of data availability issues, the results with regional fixed effects will tend to have large standard errors, as we are trying to estimate 13 fixed effects in addition to the control variables. Regardless, the general patterns hold with both area and regional fixed effects.

We begin in the final three columns of Table 5, which show how urbanization in resource exporters differs from non-exporters. In these columns we regress imports of food (column (4)), manufacturing (column (5)), and services (column (6)) as a percent of GDP, averaged over 2000–2010, against resource exports. In each column, the coefficient on resource exports is positive and significant, indicating that resource-led urbanization disproportionately drives up imports of these various goods and services. The second-to-last row of the table shows a separate F-test for the difference in the coefficient on resource exports and the coefficient on manufacturing and services in GDP. For both food (column (4)) and services (column (6)) the coefficients are significantly different. This implies that while imports go up as either resources or manufacturing and services rise, the effect is stronger for resources.

In Table 6 we repeat this type of analysis, only now using the composition of urban employment as the dependent variable. The data on urban composition of labor is novel to this paper, and it allows us to ask questions concerning the "nature" of urbanization in developing countries. We use IPUMS census data, labor force surveys, and household survey data to measure the sectoral composition of urban employment for as many countries as possible in

Table 5 Multivariate cross-sectional analysis, mechanisms

Dependent variable	Log GDPpc	Urbanization rate (%, 2010)		Imports (% GDP, 2000–10)		
	(PPP cst 2005$ Av. 1960–2010) (1)	(2)	(3)	Food (4)	manuf. (5)	serv. (6)
Natural resource exports	0.05***	0.75***	0.13	0.16**	0.37*	0.24***
(% GDP, Av. 1960–2010)	(0.01)	(0.16)	(0.18)	(0.06)	(0.21)	(0.05)
Manufacturing & services	0.03***	0.45***	0.06	0.08**	0.23	0.05
(% GDP, 2010)	(0.01)	(0.11)	(0.10)	(0.04)	(0.15)	(0.05)
Log GDP per capita			12.8***	−1.71**	5.95	0.77
(PPP cst 2005$, Av. 1960–2010)			(2.36)	(0.80)	(4.28)	(1.32)
Urbanization rate				0.00	−0.51**	−0.08
(%, 2010)				(0.03)	(0.19)	(0.07)
F-test [p]: nat. res. exp.	8.4***	5.2***	0.2	5.2**	0.7	21.5***
–Manuf. & serv. = 0	[0.00]	[0.03]	[0.66]	[0.03]	[0.42]	[0.00]
Controls, region FE (13)	Y	Y	Y	Y	Y	Y
Observations	116	116	116	110	110	112

Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The sample consists of 116 countries that were still developing countries in 1960. All regressions are population-weighted, include region fixed effects and the same controls as in Table 1. We do not control for initial conditions in 1960. Column (1) uses log GDP per capita as the dependent variable, while column (3) uses it as a control. In column (4)–(6) the dependent variables are the average shares of food, manufacturing and service imports in GDP (%) in 2000–2010. We use the average shares in 2000–2010 due to their sensitivity to fluctuations in world prices. The F-test shows whether the relationship between urbanization, income and trade is different in resource-exporters than in industrial countries for the same economic conditions. See Web Appendix for data sources and construction of variables

2000–2010. For each country, we measure the urban employment shares of 11 sectors.[29] We focus on urban tradables, i.e. "manufacturing" (*Manuf.*), and "finance, insurance, real estate and business services" (*FIRE*) as an imperfect proxy for tradable services.[30] Lack of surveys for some countries limits our sample to a maximum of 85 observations. Full details on the sources of this data can be found in the Web Appendix. As seen in column (1), the urban employment share of manufacturing and FIRE workers is significantly lower in resource-exporters.[31] In contrast, the share of manufacturing and services in GDP is positively but insignificantly related to the urban employment share of those sectors.

Column (2) shows, however, that resource exports are associated with a distinctly *larger* share of workers in commerce and personal services.[32] In column (3), there is a positive effect of resource exports on the share of government workers in urban employment, and this effect is statistically different from the essentially zero effect of manufacturing and services in GDP on government workers. Column (4) restricts the analysis to the worker shares in only the largest city in each country. As can be seen, the share of manufacturing and FIRE workers is still distinctly smaller when resource exports are higher. Panel B of Table 6 gives the same essential story even when region fixed effects are included. While the point estimates are not significant themselves, the difference between the effect of resources and manufacturing and services is significant, as shown by the F-test in the final row of Panel B. A country experiencing a 1 % point increase in resource exports would see a smaller change in manufacturing and FIRE workers than one experiencing a comparably sized increase in the manufacturing and service share of GDP.

The final two columns of Table 6 give some evidence that output per worker is lower in resource exporting countries. In both panels, the effects of resource exports on manufacturing output per worker are insignificantly positive, while an increase in the manufacturing and service share of GDP is positively and significantly associated with higher output per worker. For the service sector, an increase in resource exports is associated with a significantly lower output per worker, while the effect is positive for the manufacturing and service share. Recall that columns (5) and (6) include income per capita as a control, so these are marginal effects in these sectors, holding overall income per capita constant. This suggests that cities in resource exporters may not have the "right" types of manufacturing and services (i.e., formal manufacturing and tradable services). Jedwab and Osei (2013) show that in Ghana, productivity is only one-tenth as high in informal manufacturing as in formal manufacturing. McMillan and Rodrik (2011) find that productivity is three times higher in the FIRE sector than in other service sectors for the world in 2005 (see their Table 2). These results should

[29] We use data for the most recent year. When no data could be found for the period 2000–2010, we use data for the 1990s. Similarly to McMillan and Rodrik (2011), the 11 sectors are: "agriculture", "mining", "public
Footnote 29 continued
utilities", "manufacturing", "construction", "wholesale and retail trade, hotels and restaurants", "transportation, storage and communications", "finance, insurance, real estate and business services", "government services", "education and health" and "personal and other services".

[30] FIRE includes real estate services, which are mostly non-tradable. However, census and survey data rarely distinguish them from other FIRE sectors, which leaves us no choice but to include them.

[31] For example, as noted above, Kuwait and Japan have similar per capita incomes and urbanization rates, but Kuwaiti cities have a lower employment share of manufacturing and FIRE workers (11 vs. 33 %). Other pairs of countries for which we corroborate this hypothesis are: Saudi Arabia vs. South Korea and Taiwan; Gabon and Libya vs. Mexico, Chile and Malaysia; and Angola vs. China and The Philippines.

[32] The "commerce and personal services" sector consists of "wholesale and retail trade, hotels and restaurants", "transportation, storage and communications" and "personal and other services". We lump them together to capture the whole commerce and personal services (*Pers.Serv.*) sector.

Table 6 Cross-sectional analysis, urban employment composition

Dependent variable	Urban employment share (%, 2000–10)				Log GDPpw	
	Manuf. & FIRE	Commerce pers. serv.	Govt serv.	Manuf. & FIRE	(PPP cst 2005$, 2000–10)	
Cities (Columns (1)–(4)):	All (1)	All (2)	All (3)	Largest (4)	Manuf. (5)	Services (6)
Panel A: including controls, area FE (4)						
Natural resource exports	−0.37**	0.43***	0.11	−0.39***	0.01	−0.02**
(% GDP, Av. 1960–2010)	(0.14)	(0.15)	(0.08)	(0.15)	(0.01)	(0.01)
Manufacturing & services	0.14	0.05	−0.00	0.11	0.03***	0.01**
(% GDP, 2010)	(0.10)	(0.12)	(0.06)	(0.10)	(0.01)	(0.00)
F-test [*p*]: nat. res. exp.	30.6***	12.9***	5.1**	15.0***	2.2	21.0***
–Manuf. & serv. = 0	[0.00]	[0.00]	[0.03]	[0.00]	[0.14]	[0.00]
Panel B: including controls, region FE (13)						
Natural resource exports	−0.17	0.20	0.17*	−0.26	0.01	−0.02*
(% GDP, Av. 1960–2010)	(0.14)	(0.17)	(0.10)	(0.16)	(0.02)	(0.01)
Manufacturing & services	0.17	−0.00	0.03	0.08	0.03**	0.01*
(% GDP, 2010)	(0.11)	(0.13)	(0.06)	(0.11)	(0.01)	(0.01)
F-test [*p*]: nat. res. exp.	28.6***	3.6*	4.8**	8.7***	2.9*	14.8***
–Manuf. & serv. = 0	[0.00]	[0.06]	[0.03]	[0.00]	[0.10]	[0.00]
Observations	88	83	83	85	111	111

Robust SEs in parentheses; * p<0.10, ** p<0.05, *** p<0.01. The main sample consists of 116 countries that were still developing countries in 1960. In Panel B, the regression is the same model as in column (6) of Table 5. All regressions are population-weighted, include region fixed effects and the same controls as in Table 1. We control for mean income in 1960–2010 and the urbanization rate in 2010. In Panel A, we include area fixed effects instead of region fixed effects. We examine the urban employment composition of 88 countries for the most recent year available (in 2000–2010 mostly). In columns (1)–(3) the dependent variables are the urban employment shares of "manufacturing" and "finance, insurance, real estate and business services" (*Manuf. & FIRE*), "wholesale, retail trade, hotels and restaurants", "transportation, storage and communications" and "personal and other services" (*Commerce & Pers.Serv.*) and "government services" (*Govt Serv.*). In column (4), we use data for the largest city only. In columns (5)–(6) the dependent variable is log GDP per worker (PPP cst 2005$) in the manufacturing and service sectors at the national level in 2000–2010. The F-test shows whether cities/productivities in resource-exporters are significantly different from cities/productivities in industrial countries for the same economic conditions. See Web Appendix for data sources and construction of variables

Table 7 Cross-sectional analysis, other characteristics

Dependent variable (2000–10)	Total Gini (%)	Urban Gini (%)	Primacy Rate (%)		Urban years of education	Returns to education Schoellman	Price index largest
			Largest city	Five largest			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: including controls, area FE (4)							
Natural resource exports	0.43***	0.31	−0.11	−0.06	−0.00	−0.01	0.06
(% GDP, Av. 1960–2010)	(0.12)	(0.18)	(0.21)	(0.35)	(0.03)	(0.06)	(0.30)
Manufacturing & services	0.22**	0.36***	−0.00	0.02	−0.00	0.08*	−0.55**
(% GDP, 2010)	(0.09)	(0.11)	(0.14)	(0.19)	(0.04)	(0.04)	(0.26)
F-test [*p*]: Nat. Res. Exp.	5.7**	0.1	0.5	0.08	0.01	4.7**	5.5**
–Manuf. & Serv. = 0	[0.02]	[0.76]	[0.50]	[0.78]	[0.92]	[0.04]	[0.02]
Panel B: including controls, region FE (13)							
Natural resource exports	0.36***	0.04	0.02	0.19	0.01	0.01	0.03
(% GDP, Av. 1960–2010)	(0.14)	(0.22)	(0.20)	(0.28)	(0.03)	(0.07)	(0.26)
Manufacturing & services	0.18**	0.17	0.10	0.13	0.01	0.09**	−0.14
(% GDP, 2010)	(0.08)	(0.12)	(0.13)	(0.20)	(0.03)	(0.04)	(0.21)
F-test [*p*]: nat. res. exp.	3.3*	0.6	0.3	0.1	0.0	1.9	0.3
–Manuf. & Serv. = 0	[0.07]	[0.43]	[0.59]	[0.75]	[0.97]	[0.18]	[0.57]
Observations	102	72	116	116	97	73	111

Robust SEs in parentheses; * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The sample consists of 116 countries that were still developing countries in 1960. In Panel B, the regression is the same model as in column (6) of Table 5. All regressions are population-weighted, include region fixed effects and the same controls as in Table 1. We control for mean income in 1960–2010 and the urbanization rate in 2010. In Panel A, we opt for area fixed effects. The dependent variables are country and city characteristics for the most recent year available (2000–2010). The F-test shows whether they are significantly different between resource-exporters and industrial countries. See Web Appendix for data sources be taken with some caution. The persistence of resource exporting in the resource-dependent countries is at least partly a reflection of low productivity in the tradable sector.

Table 7 continues the analysis for a variety of different outcome variables. Columns (1) and (2) look at inequality. The total Gini, covering the entire population, is the dependent variable in column (1), which again includes controls for the urbanization rate and income per capita. Here we see that a higher Gini is associated with resource exporters, even holding constant the manufacturing and service share in GDP. However, if we look at column (2) the urban Gini, measuring inequality only for urban residents, is not significantly higher in resource exporters. This suggests that resource exports generate inequality *between* urban and rural areas.[33] While urbanization occurs in response to greater resource rents, it is limited enough that incomes in urban and rural areas do not converge. This result is consistent with the presence of dual economies within developing countries, where some type of barrier (either explicit or implicit) prevents earnings from being equalized across sectors (Vollrath 2009a, b; Lagakos and Waugh 2013; Gollin et al. 2014). Resources may exacerbate this kind of inequality more than manufacturing and services because they generate very relatively few jobs directly, or perhaps because they cause the selection of particularly skilled rural workers to move to cities.

In comparison, we see no tendency towards urban primacy (i.e. the share of urban population in the largest city or cities) being driven by resource exports. While it is true that China and India have low primacy rates, there are also many resource-exporters with a low primacy rate, such as Botswana, Iran, Nigeria or Venezuela. Conversely, there are many non-resource exporters with a high primacy rate, e.g. Cambodia, Lebanon, South Korea and Uruguay. Columns (3) and (4) of Table 6 show that there is no effect of resource exports on primacy, measured using either the largest city (column (3)) or the five largest (column(4)). Resource exporters do not appear to concentrate the urban population more highly than in other countries. This result indicates that the effect on the composition of urban labor seen in Table 6 is general to all urban areas of the economy and is not driven by a flood of workers into the largest cities.[34]

Columns (5) and (6) of Table 7 examine the effect of resources on urban education. In column (6), the dependent variable is the average years of education in urban areas for the most recent year available in the period from 2000 to 2010.[35] This is not significantly affected by resource exports, nor is there a differential effect of resources compared to manufacturing and services. When using the country-specific returns to education in 2000 estimated by Schoellman (2012) as a dependent variable for 73 countries of our sample (column (6)), we find that these returns are relatively lower in resource exporters, given the same economic conditions. While this measure is not specific to the cities of these countries, it suggests that the quality of their education systems could be indeed lower.[36]

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[33] Web Appendix Table 14 shows that the urban-rural gap in terms of access to improved water, access to improved sanitation facilities, or usage of non-solid fuels as a main source of energy, is indeed more pronounced in resource-exporting countries than in industrial countries. The non-result for inequality within urban areas should then be taken with caution, as urban Ginis are usually measured using household survey data for the urban areas, which may not capture well the top of their income distribution. In contrast, total Ginis may be computed using several sources of data, including tax records.

[34] Web Appendix Table 15 examines urban primacy in our panel specification, and again finds no significant relationship with resource exports.

[35] This variable is created using the same IPUMS and survey data we used to generate the data on urban labor composition.

[36] Schoellman (2012) uses the returns to schooling of foreign-educated immigrants in the United States to measure the education quality of their birth country. The returns are thus based on the returns achieved in a common labor market.

Lastly, column (7) of Table 7 shows that a price index for expatriates in the largest city in a country is significantly lower as the share of manufacturing and services in GDP rises—but is not related to resource exports.[37] The difference between these effects is significant, given the F-test, and indicates that resource-led urbanization is not necessarily associated with cheaper goods and services, in contrast to the patterns observed for urbanization in industrializing countries.

A "resource curse" is often associated with poor institutions. While it is true that resource exports are significantly associated with lower Polity scores and poorer World Bank "Doing Business" scores (see Web Appendix Table 16), including these institutional controls in either our cross-sectional regressions (see Web Appendix Table 17) or panel regressions (see Web Appendix Table 18) does not seem to have any effect on the relationship between resources and urbanization. Dependence on resource exports arguably indicates poor institutions, but this effect does not appear to operate through a channel of institutional quality.

The next set of results we consider deal with the standard of living in urban areas, found in panels A and B of Table 8. Our main measure of urban economic development is the urban poverty headcount ratio, i.e. the percentage of the urban population living below the urban poverty line (%). We find that resource exports do not change poverty in a manner similar to industrial countries (column (1)). Whereas a higher share of manufacturing and services in GDP is associated with lower poverty, this is not the case with resource exports, and the difference in the two effects is statistically significant given the reported F-test. This result is robust to using the urban poverty gap (%)—the mean shortfall from the poverty line as a percentage of the urban poverty line—as the dependent variable instead (column (2)). Slum data was generated using UN-Habitat (2003) and United Nations (2013) data. Although data collection on slums began in 1990, 2005 is the first year in which the data were systematically collected across countries. We find that resource exports do not lower the slum share nearly as much as do manufacturing and services (column (3)).

A slum household is defined as a group of individuals living under the same roof lacking one or more of the following conditions UN-Habitat (2003): (i) access to an improved water source, (ii) access to improved sanitation facilities, (iii) sufficient-living area, and (iv) durability of housing.[38] We study the various subcomponents of the slum variable. Data is available for a smaller number of countries for some subcomponents. Urban inhabitants in resource-exporters do not see the same benefits to improved water sources and sanitation facilities (columns (4)–(5)), as evidenced by the significant difference between the coefficients on resource exports and the manufacturing and service share in GDP. Overall, the results suggest that resource-led consumption cities do not deliver welfare gains to the same extent as production cities.[39]

The last piece of analysis, in panel C of Table 8, considers the reduced form effect of resources on urban development by *excluding* income per capita and urbanization as controls. Columns (1) and (2) show that, on net, resource exports have no effect on urban poverty, even

[37] The dependent variable was recreated using existing data on the relative prices of various goods and services for expatriates for the largest city of each country. See Web Appendix for more details. As an example, Luanda in Angola is at least two times more expensive for expatriates than Shanghai in China, although Angola and China have similar income and urbanization levels.

[38] A household is considered to: (i) have access to an improved water source if the household has easy access to drinking water, (ii) have access to improved sanitation if an excreta disposal system is available to the household, (iii) have sufficient-living area if the household lives in dwelling units with less than 2 persons per room, and (iv) live in a durable residence if the residence is built on a non-hazardous location and has a structure permanent and adequate enough to protect its inhabitants from extreme climatic conditions.

[39] Results also hold when controlling for government expenditure in 2010 (Web Appendix Table 19).

Table 8 Cross-sectional analysis, urban economic development

Dependent variable (2000–10):	Urban poverty headcount ratio (%)	Urban poverty gap (%)	Slum share urban pop. (%)	Urban population (%) with access to:			
				Improved water source	Improved sanitation facilities	Sufficient living area	Non-solid fuels as energy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: including controls, area FE (4)							
Natural resource exports	0.02	0.23	−0.31	0.05	−0.08	0.40	0.46
(% GDP, Av. 1960–2010)	(0.29)	(0.15)	(0.25)	(0.16)	(0.22)	(0.36)	(0.34)
Manufacturing & services	−0.32	−0.13	−0.48**	0.27*	0.15	0.36	0.52**
(% GDP, 2010)	(0.21)	(0.09)	(0.21)	(0.13)	(0.15)	(0.43)	(0.24)
F-test [p]: nat. res. exp.	2.7*	7.9***	0.5	3.8*	2.3	0.0	0.0
–Manuf. & Serv. = 0	[0.10]	[0.01]	[0.47]	[0.06]	[0.13]	[0.87]	[0.83]
Panel B: including controls, region FE (13)							
Natural resource exports	0.26	0.29	−0.17	−0.04	−0.15	0.28	0.61
(% GDP, Av. 1960–2010)	(0.32)	(0.18)	(0.29)	(0.21)	(0.26)	(0.40)	(0.41)
Manufacturing & services	−0.22	−0.05	−0.59***	0.25	0.17	0.72**	0.57**
(% GDP, 2010)	(0.20)	(0.10)	(0.19)	(0.17)	(0.16)	(0.29)	(0.26)
F-test [p]: nat. res. exp.	4.4**	5.4***	3.4*	5.7**	3.5*	3.1*	0.0
–Manuf. & serv. = 0	[0.04]	[0.03]	[0.07]	[0.02]	[0.07]	[0.09]	[0.89]

Table 8 continued

Dependent variable (2000–10):	Urban poverty headcount ratio (%)	Urban poverty gap (%)	Slum share urban pop. (%)	Urban population (%) with access to:			
				Improved water source	Improved sanitation facilities	Sufficient living area	Non-solid fuels as energy
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel C: no controls for income and urbanization, region FE (13)							
Natural resource exports	−0.08	0.03	−0.81***	0.02	0.39*	0.43	1.31***
(% GDP, Av. 1960–2010)	(0.24)	(0.17)	(0.26)	(0.18)	(0.23)	(0.30)	(0.42)
Manufacturing & services	−0.40**	−0.18*	−0.98***	0.29**	0.51***	0.69**	0.97***
(% GDP, 2010)	(0.18)	(0.09)	(0.16)	(0.13)	(0.14)	(0.27)	(0.25)
Observations	85	58	115	112	112	61	90

Robust SEs in parentheses; * $p<0.10$, ** $p<0.05$, *** $p<0.01$. The sample consists of 116 countries that were still developing countries in 1960. In Panel B, the regression is the same model as in column (6) of Table 5. All regressions are population-weighted, include region fixed effects and the same controls as in Table 1. Except in Panel C, we control for mean income in 1960–2010 and the urbanization rate in 2010. In Panel A, we opt for area fixed effects. The dependent variables are measures of urban economic development for the most recent year available (2000–2010). The F-test shows whether these measures are significantly different between resource-exporters and industrial countries. See Web Appendix for data sources though we have established that incomes rise appreciably. This suggests that the urban Gini coefficient seen in Table 7 may not be picking up the full impact of resources on the income distribution. Compare the lack of a reduced form effect of resources on urban poverty to the significant effect of manufacturing and services, which distinctly lowers poverty. In column (3) of panel C, though, the share of people in slums falls regardless of whether resources or manufacturing and services rise. Similarly, there appear to be positive effects of resources on sanitation (column (5)) and access to non-solid fuels (column (7)).

Resources lead to urbanization, but this urbanization is of a different type than that found in non-exporters. Resource-led urbanization appears to create what we term "consumption cities". These cities tend to be composed of workers in non-tradable services. Imports of various kinds are more prevalent in these countries, consistent with workers being skewed towards non-tradable services while resource rents pay for imported goods. "Consumption cities" also appear to offer poorer living conditions than cities in non-exporters, despite being formed by similar shocks to income. Non-exporters, in comparison, appear to urbanize through what we term "production cities." These cities are made up more heavily of manufacturing and workers in the tradable service sector. Production cities import fewer goods and tend to have more access to urban improvements.

6 Discussion and conclusion

The recurring theme in this paper is that urbanization is not a homogeneous event. Countries can, and do, urbanize through expansion of their natural resource exports as well as through the more traditional channel of industrialization. Empirically, we documented that the relationship between resources and urbanization is robust to the inclusion of a variety of controls and holds both in the cross-section and panel. Using discoveries and price fluctuations as instruments, there is supporting evidence that the effect of resources is causal for urbanization. The evidence suggests that resource rents can drive urbanization just as effectively as industrial development. But the cities that grow in resource-exporting countries are different. Their urban labor force is allocated to different sectors: more workers are in non-tradable services (e.g. personal services and commerce) and fewer are employed in tradable sectors (e.g. manufacturing and FIRE), compared to countries that do not depend on resource exports. There is also evidence that living conditions in these "consumption cities", as we term them, do not match those found in the "production cities" of non-resource-exporters.

The fact that urbanization is not homogeneous opens up the possibility that future growth may depend on whether urbanization is resource-led or industry-led. If there are particularly strong learning-by-doing effects in the tradable sector, then resource-led urbanizations will lead to relatively slow productivity growth due to the small size of that tradable sector. Modeling this explicitly is beyond the scope of this paper, but our work shows that it may be a fruitful way of understanding differences in urban productivity growth across countries. At the same time, it is perfectly conceivable that consumption cities could become production cities over time.[40] Gold rushes led to the growth of cities such as San Francisco (from 1848), Denver (1858) and Seattle (1896). Giant oil discoveries help explain why Texan cities have been among the fastest-growing cities in the 20th century. Despite being examples of resource-led urbanization, these cities all industrialized in the long run. Consumption cities

[40] As shown by Michaels (2011), resource production can promote long-term development when institutions are strong. Campante and Glaeser (2009) document how human capital and political stability can explain the divergent paths of Chicago and Buenos Aires, which both began as consumption cities in our typology.

may ultimately be welfare-improving, even if they appear to fare worse than production cities in the short run. Understanding what distinguishes successful consumption cities from unsuccessful ones is beyond the scope of this paper but offers an intriguing area for further research.

Regardless of future implications, we believe there is value in showing that urbanization is more than a synonym for industrialization. Understanding the dynamics of resource-led urbanization will be important for thinking about the growth of cities and the process of development. Our results are not driven by a handful of extreme resource-exporters (e.g. Saudi Arabia) but instead hold across a whole range of developing nations. The size of the estimated effect is quite strong, indicating that an appreciable shock to resource exports (e.g. from a discovery) can raise the urbanization rate by 10–12 %points over several decades. Given the widespread reliance on resource exports in developing nations, and especially in Africa, a significant portion of urbanization in the developing world over the last few decades has been driven by resources. The implications for the long-run relationship between urbanization and growth remains a question for the future.

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