Urban Growth and Uninsured Rural Risk: Booming Towns in Bust Times

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Abstract

The level of urbanization has increased by over 5 percentage points per decade outside the developed world since 1960. Rapid urbanization was accompanied by fast economic growth and job creation in most parts of the world. However, notably Africa (and Latin America after 1980) has had a different experience: while growth in GDP per capita slowed significantly or even reversed, the rate of urbanization continued its fast pace. This paper aims to explain this by introducing an aggregate risk differential between the countryside and the city. Uninsurable expected risk will lead to rural-urban migration as a form of ex-ante insurance if households are liquidity constrained in incomplete markets and cannot overcome adverse shocks. Aggregate agricultural risk has a robust positive effect on urban growth, also when economic growth is slow. The effect stands up to the transitional view on urbanization of economies shifting from an agricultural to an industrial base, and to several alternative explanations such as (urban) government spending.

Key words: urbanization, risk, natural resources, volatility, rural-urban migration
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1 Introduction

The level of urbanization has increased by over 5 percentage points per decade outside the developed world since 1960. As a result, sometime this year the world will have more urban inhabitants than rural dwellers. Rapid urbanization was accompanied by fast economic growth in most parts of the world, reflecting the transitional shift from agriculture to industrialization as countries develop. However, notably Africa (and Latin America after 1980) has had a different experience (Fay and Opal, 2000) as is shown in Figure 1. While growth in GDP per capita slowed significantly or even reversed, the rate of urbanization continued at a fast pace. Table 1 ranks regions by the growth differential between the national and the urban population. Given the low rate of GDP per capita growth in Sub-Saharan Africa it is surprising that it comes on top in terms of speed of urbanization. Without growth to create jobs or higher wages in cities (such as in East Asia) it seems puzzling that so many rural dwellers choose to become urban inhabitants. Most people end up in slums which do not necessarily offer better living conditions than rural areas for a given income (UN-Habitat, 2006). The long time period and crowding should lower the expected income gain from moving to the city. Big city lights are not always bright. It seems that the continued migration flows in some parts of the world are larger and more persistent than the classic Harris-Todaro (1970) model can explain. An illustration is given by Cameroon, a Sub-Saharan African country. Between 1990 and 1995 its urban population grew 13% faster than the national population, yet GDP per capita and manufacturing value added were declining by respectively -3% and -5% per year on average.

Can the observed persistent trend in urbanization be explained by push factors? Apart from being pulled to the city by a promise of higher income, people may also be pushed from rural areas if living conditions worsen in the countryside. When sources of income decline (by natural causes such as rainfall or conflicts for example) people will move to cities even if urban economic growth is absent, because it is the only place to go with at least some chance of improvement. Even if rural life exhibits good as well as bad years then people are still pushed off the land and to the city in bad years, unless they have the financial means to smooth consumption and 'ride out the bad times'. The more volatile shocks are, the more likely bad years will occur that wipe out savings. Natural resource production such as agriculture and the exogenous prices they fetch on the world market show very volatile behavior (Deaton, 1999), while financial services to insure against shocks are relatively absent in rural areas (Collier, Gunning, 1999).

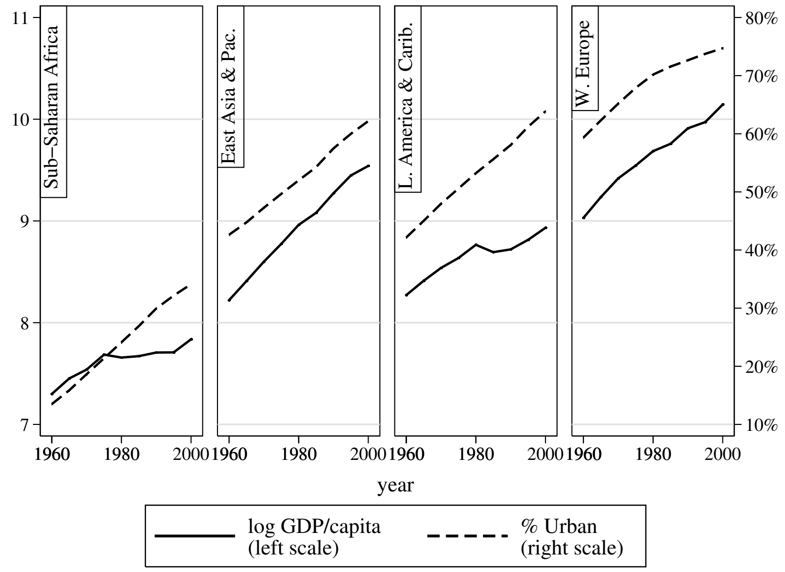

Fig. 1. Growth and urbanization

Table 1
Economic and Urban Growth by Region (yearly %, 1970-2000)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	GDP/capita growth		% Population growth			% Agri.	Volatility of agri. growth		% Urban	
	mean	sd	urban	total	(3)-(4)	mean	<'80	≥'80	1970	2000
Sub-Saharan Africa	1.05	6.15	5.78	2.85	2.93	32.9	9.0	9.7	19.0	36.1
South Asia	2.65	3.98	5.17	2.48	2.69	37.4	4.8	4.9	12.8	21.4
East Asia & Pacific	2.60	4.76	3.30	1.90	1.40	19.8	8.8	7.3	38.6	51.3
Middle East & North Africa	2.08	7.66	5.00	3.83	1.16	8.6	12.6	12.7	60.0	76.3
Latin America & Caribbean	1.77	4.04	2.65	1.68	0.97	12.8	5.7	6.1	49.7	63.6
Western Europe	2.82	2.21	1.03	0.52	0.51	5.9	6.5	6.2	65.6	74.7
Eastern Europe & Central Asia	2.11	7.01	0.67	0.35	0.32	20.2	6.6	12.6	47.7	58.5
North America	2.33	2.08	1.32	1.11	0.21	2.5	5.6	6.7	74.7	79.3

Note: Ordered on column 5. Means (or standard deviations) are calculated as the within-region cross-country unweighed average (or standard deviation) of country-time-period average growth rates (or standard deviations).

Sub-Saharan Africa is very dependent on agriculture, even without counting subsistence farming, and has a high degree of rural risk, as measured by the volatility of agricultural value added growth (see Table 1). Rural risk increased after 1980 both in Africa and Latin America.[2] The example of Cameroon did not suffer from war or conflict in the 1990s, but output growth volatility in the agricultural sector was a worrying 10%. The negative agricultural growth shock of -13.0% in 1992 (while world food export prices had been declining for three years) may well have pushed farmers to cities to find alternative income sources, if they could not use financial instruments to wait for next year's positive shock of +12.7%. Risk was evidently high.

This paper will try to explain urbanization occurring even under negative growth, by examining another feature of many developing countries: the (uninsurable) risk involved in dependence on agriculture and natural resource production. Agricultural risk may come from supply shocks, for example from shocks to rainfall, or from large swings in prices. Figure 2 shows cumulative density functions for four resources, and general price indices for manufacturing products and the world. The x-axis shows the size of yearly standard deviations in % monthly inflation. It is clear that a country with a high dependence on, for example, food products faces much more volatile prices than (OECD) countries which typically trade in manufactures, and food prices are as volatile as the prices of ores & metals.[3] In almost half of all periods food price shocks were more severe than oil price shocks, prompting large price stabilization schemes in the 1970s which had many pitfalls and adverse side effects as studied in Newbery and Stiglitz (1981).

The next section presents the main hypotheses in the light of the existing literature and describes possible alternative explanations for continued urban growth. Section 3 derives a model of migration as an ex-ante response to risk, leading to the econometric specification presented in section 4. Section 5 addresses concerns for endogeneity, and section 6 describes the results. Section 7 presents an out-of-sample forecasting exercise to see if the observed aggregate trend can be explained by the model. Section 8 concludes.

[2] Agricultural risk became also high in Eastern Europe & Central Asia, but the region is less dependent on agriculture and economic growth was up to twice as high.

[3] Crude oil has a different scaling because of the oil crisis. The series 'OECD Manuf. PPI' (manufacturing producer price index) starts in 1982.

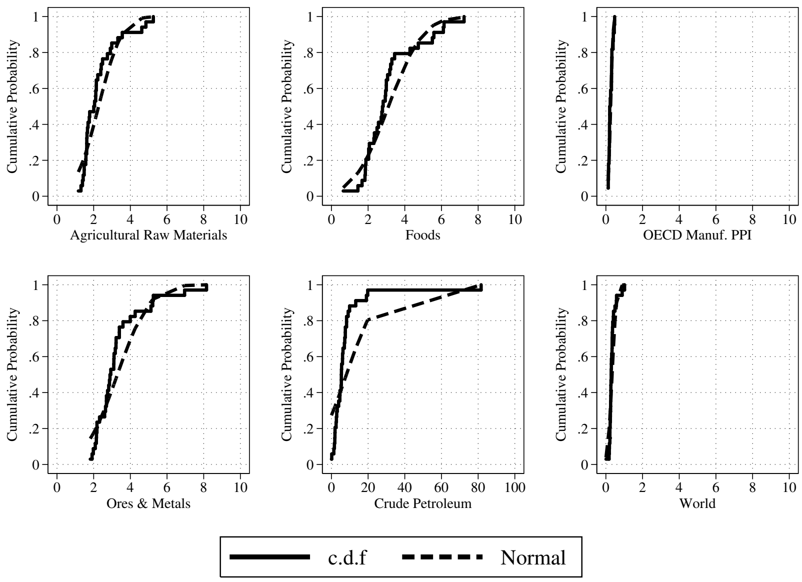

Fig. 2. Densities of Yearly Standard Deviation of Monthly Price Index Inflation, 1970-2003

2 Risk, insurance and alternative explanations

Risk need not be a problem if financial instruments were available to insure against such risk. Households in industrialized countries can deal with risk by buying financial services such as savings and checking accounts, (unemployment) insurance, pensions, bonds, loans, etc., enabling them to smooth consumption over time. Most of these services are however beyond the reach of most people in developing countries, especially outside the urban environment where fewer if any of these services are provided. Evidence that especially rural areas suffer from lack of credit and saving markets comes from Taylor et al. (1996), who document the failure of local credit and risk markets. Conning and Udry (2007) also report the extend of imperfections in rural capital markets, for example pointing out that microfinance has mostly focused on urban or non-farm activities. Commercial financial intermediaries are mostly confined to urban areas with more opportunity to diversify their portfolio. Even inside cities a dual economy exists, the formal and the informal one, both in terms of labor and in terms of housing (see i.e. Temple, 2005). Slum dwellers will find it much harder to smooth consumption because they cannot provide collateral or a credit history. Such incomplete markets affect not only households' (ex-post) income, but may also affect their (ex-ante) behavior, possibly resulting in migration to cities.[4] Furthermore, cities are centers of trade and political power and offer more diverse sources of income than rural areas.[5] At least they offer a chance of improving living conditions.

Insurance may partly be obtained by various informal means, as described in Besley (1995). Ex-post risk sharing, which usually happens at the village level among households, takes the form of (cross-sectional) transfers that pool risk and income and provide insurance against idiosyncratic shocks. However, it requires strong information and enforcement institutions within the community (Udry, 1990) and the larger the covariance of shocks among households, the less scope there is for this form of insurance. Aggregate community shocks cannot be insured in this way. Townsend (1994) and others (i.e. Bardhan and Udry, 1999) find that Pareto efficient risk pooling is often not achieved. Transfers across time may provide additional insurance, but Rosenzweig and Binswanger (1993) find that this is also limited because of credit constraints. Moreover, it leads households to choose less risky investment projects with a lower return, adversely affecting productive efficiency.[6] Accumulation of buffer stocks (often in the form of bullocks) may also be used to smooth consumption (Deaton, 1991), but this can also affect production if these assets are used in production (Rosenzweig and Wolpin, 1993) and is thus a sub-optimal insurance method.

Uncertainty and risk as a motive to migrate (for some family members) was already noted by Stark and Levhari (1982). Daveri and Faini (1999) have estimated this motive for Italian migrants within Italy and internationally and conclude that risk is a significant determinant, driven by risk aversion. Dustmann (1997) similarly models the *duration* of

[4] Ex-ante insurance takes the form of conservative investment decisions, such as postponing adoption of new risky technology, crop diversification, crops of lower yields but faster growth cycles, diversifying family members among different income activities or sharecropping. It is also related to remittances and risk diversification by means of assigning family members to work in a different area, country or sector such as in Stark and Lucas (1988).

[5] See Ades and Glaeser (1995) on the effects of trade and politics on urban concentration.

[6] Risk usually commands a higher return because otherwise the project would never be started, but in a rural development country setting risk might be high even with low return if social and financial constraints limit the ability to change predetermined investments, such as being born on a family (subsistence) farm.

international migration as it is determined by risk at home and abroad and the (intertemporal) covariance of labor market shocks in addition to a wage differential. For example, a temporary migrant may diversify risk if the covariance of shocks is negative. At the household level, the importance of ex-ante strategies to deal with risk is shown for example by Giles (2006). Rural households in China use off-farm labor markets to reduce exposure to ex-ante risk and to increase ex-post smoothing opportunities. This strategy only became possible after (temporary) migration to urban areas became legal in 1988, allowing families to diversify income. Urbanization in China is however not surprising in a time of an economic growth miracle. Similar evidence for ex-ante strategies comes from India where households are more likely to participate in the labor market in regions with higher rainfall risk (Rose, 2001). Households seem to obtain insurance by letting one or more household members migrate to other areas with less, or uncorrelated, income risk, expecting remittances to supplement total household income, as happens in Thailand (Paulson, 2000) where the destination of choice is the city of Bangkok.[7] The migration choice is essentially a portfolio choice where households decide on the distance (for example home or foreign destination) and on which (or how many) household members to send (Azam and Gubert, 2006). The relative importance of ex-ante risk insurance is also shown by Elbers et al. (2005). They use micro data to quantify the ex-post and ex-ante effects of risk on capital accumulation and find that two-thirds of the detrimental effect of risk is due to the ex-ante type which influences households' behavioral decisions. These alternative risk-coping strategies become all the more important if financial markets are underdeveloped and no financial means to insure against risk exist. However, risk as a motive to migrate is not the only possible reason for continued urbanization.

A second explanation for Africa's specific experience uses rainfall data (Barrios et al., 2006) and shows that low rainfall (low agricultural productivity) is associated with

[7] Other strategies may even include increased fertility to compensate expected losses due to hurricane risk, as was observed in Guatemala, or by investing more in education to diversify income through migration if families do not own land (Pörtner, 2008).

a higher contemporary level of urbanization. A third explanation comes from Fay and Opal (2000) and Davis and Henderson (2003) who identify government policy resulting in 'urban bias' and artificially high urban wages as an important cause for high levels of urbanization, in combination with urban poverty.[8] Government involvement may also introduce government jobs or subsidies as winning tickets to the 'lottery' for formal urban employment (Fields, 1975). In that case rural workers may choose to migrate even if living standards are lower in the informal urban sector, as long as it offers the possibility to win a formal job. Government spending may therefore keep cities attractive if it can compensate for lagging job growth under continued rural-urban migration, which would otherwise significantly lower the probability of winning. We will test the risk channel alongside these two alternative hypotheses.

We build on the existing empirical literature on urbanization, which implicitly relies on economic growth of the urban manufacturing sector to generate a rural-urban income gap and sectoral transition. For example, Brueckner (1990) specifies a monocentric-city model with rural-urban migration. He finds an important positive effect of the urban to rural income ratio on both urban population levels and growth rates, but is limited to a cross-section of 24 developing countries, as are Becker and Morrison (1988). Moomaw and Shatter (1996) estimate a larger panel sample of countries. The most robust finding is that countries with a higher share of labor in industry are more urbanized, supporting the view that urbanization takes place as a country transitions from an agricultural to an industrial base. Such a transition also motivates migrants to obtain human capital in cities while the demand for skilled jobs increases, as in Lucas (2004). If technological progress drives city growth through the industrial sector as simulated in Kelley and Williamson (1984) then urban income may continue to outpace rural income. Davis and Henderson

[8] Other explanations include democracy (more regional autonomy, so less urban bias), less than average agricultural yield (which is related to rainfall), and changes in the five-year average ratio of producer prices of wheat, rice, and maize to the country's CPI (which is often used as a proxy for rural to urban terms of trade).

(2003) estimate a 5 year panel from 1960 to 1995 and find that a shift out of agriculture to industry and the policies that affect this lead to urbanization. For example, planned economies such as China tend to restrict migration, and policy may affect the sectoral composition through for example import substitution programs.

However, why would some countries still urbanize if growth is absent? We add to the literature by focusing on risk and the hypothesized migration reaction of rural households to agricultural (rural) and manufacturing (urban) risk. Since we focus on aggregate shocks which are uninsurable by the local informal ex-post methods we hypothesize that ex-ante risk insurance is an important response. We will furthermore primarily focus on the speed of urbanization rather than the level and hypothesize that urban growth is faster in more risky periods, especially if average growth is low. Shocks around a low or negative growth rate are probably worse than shocks around a high and positive growth rate.

3 Model of ex-ante risk insurance

The theoretical reason to look at risk as an explanation for urbanization is derived as follows. We assume that households pool all income from their members. A family may choose to invest in the migration of one or more of its members (workers) who derive income from employment either in the urban area or in the rural area. [9] Household income may then be supplemented with remittances from any members employed outside the home rural area as a return on family investment to migration. The choice of location is directly tied to sectors of the economy. The rural area only offers agriculture and other natural resource production. It is risky because income depends on nature, such as rainfall, and on demand and price shocks for natural products. Moreover, the rural area is a single sector economy with little scope for diversification. The urban area instead consists of formal manufacturing jobs, an informal sector, and the possibility to obtain

[9] Migration as an investment decision goes back to Sjaastad (1962).

formal government jobs or subsidies. Government income is often spent in cities, closer to the government's supporters (Davis and Henderson, 2003). Migration will be influenced by the probability of obtaining formal income in addition to the hypothesized risk channel. [10] Furthermore, the urban sector typically has better access to financial services to insure against shocks in addition to diversification opportunities. It is therefore reasonable to assume that production and employment in the rural area is inherently more risky than employment in the urban area even though its return is not necessarily higher. Some periods are more volatile than others and a country's development over time may change the dependence on natural resources and its ability to cope with external shocks. A time dimension is therefore also important. The goal of this model is to analyze the effect of a risk differential on workers' location choice.

A representative household faces a choice to divide its members over two areas which simultaneously requires a choice between sectors. [11] Household face a liquidity constraint every period because we assume that financial markets are underdeveloped, especially in the rural areas. Lack of collateral or a credit history (and incomplete markets) prohibits borrowing such that in every period the value of assets A_t plus expected income y_t should be larger than consumption c_t.

$$A_t + y_t - c_t \geq 0 \tag{3.1}$$

Income y_t depends on the previous period 'portfolio' choice of the household migration decision which corresponds to a choice of location and hence of sector. [12] The household decides to let a share z_{t-1} of its members migrate. If $z = 1$ all members will move to the

[10] Banerjee and Kanbur (1981) used unemployment rates and inequality as measures of risk in a cross-section of Indian regions. Here risk is formulated as shocks to income.

[11] This section builds heavily on a standard risk and insurance model with a precautionary savings motive (as in Mirrlees, 1965; Deaton, 1991), see Bardhan and Udry (1999). In these models households make choices between different investments with different risk and return. Here we add the possibility that location is a choice and that each location promises a different stream of income.

[12] We could also make this choice depend on distance. Fafchamps and Shilpi (2008) show for example how spatial isolation leads to lower subjective welfare, which might be consistent with an increased need for additional income sources. Taking into account distance, the household chooses not only the share of members to migrate but also the distance to the nearest city and thus access to an external market offering more means of diversification, but this would not change our main results. See for example Brueckner and Zenou (1999) for an urbanization model with a land market.

urban area, and if $z = 0$ all remain in the rural area. Because each location has a perfectly competitive sector people can always find employment in the city: either formal or informal.[13] We assume additionally that each location faces a different degree of aggregate (multiplicative) income risk. Income is therefore a function of exogenous shocks taking place in the rural sector $\epsilon_t \sim N(1, \sigma_\epsilon^2)$ with unit mean and variance σ_ϵ^2 and in the urban sector $\eta_t \sim N(1, \sigma_\eta^2)$ (where the shock η is a combination of shocks to the manufacturing, the informal and the government sector), with known joint density function $f(\epsilon, \eta)$. However, migration is costly because it is costly to obtain information about possible destinations (which depends on distance and relates to the cost of searching for a job) and it is more difficult to remit income over greater distances. Migrants will have to pay for higher cost of living in urban areas and may have even invested in education (which has a higher return outside the rural sector). Azam and Gubert (2006) document that families send their most promising members away. In Lucas (2004), migrant workers may choose to forgo income to allow them to spend more time on searching for a better job or to acquire skills. A family with a migrated member will have to spent part of the urban income on (re)paying these costs. These costs are captured by κ. Net household income is therefore a function of the share of family members in the rural area $(1 - z)$, their (stochastic) wages $w_R\epsilon$, and (stochastic) income from urban members $w_U\eta$ net of costs κ:

$$y_t(z_{t-1}, \epsilon_t, \eta_t) = (1 - z_{t-1})w_{R,t}\epsilon_t + z_{t-1}(w_U\eta_t - \kappa) \tag{3.2}$$

The expected urban wage w_U is a combination of formal, informal and government income, weighted by the probabilities of obtaining such income. The marginal income benefit from letting more household members migrate is increasing in the urban shock: $\partial^2 y_t/\partial\eta_t\partial z_t > 0$ and decreasing in the rural shock: $\partial^2 y_t/\partial\epsilon_t\partial z_t < 0$. It is therefore crucial to form expectations on the relative riskiness of both sectors to make an optimal migration and location choice.

[13] We abstract from any unemployment benefits.

Households maximize a discounted flow of expected utility from consumption subject to their budget constraint, where r_t is the rate of return on assets:

$$\max_{c_t, z_{t+1}} E_t \sum_{\tau - t}^{T} \beta^{\tau - t} u(c_\tau) \tag{3.3}$$

$$s.t.\ A_{t+1} = (1 + r_t)(A_t + y_t - c_t) \tag{3.4}$$

Households are risk averse so $u' > 0$, $u'' < 0$ and $\lim_{x \to 0} u'(x) = +\infty$. Households therefore aim to smooth consumption over time. The corresponding period t value function is given by:

$$\begin{aligned} V_t(A_t + y_t) = \max_{c_t} \{ & u(c_t) + \beta E_t V_{t+1}[(1 + r_t)(A_t + y_t - c_t) \\ & + y(z_t, \epsilon_{t+1}, \eta_{t+1})] + \lambda_t (A_t + y_t - c_t) \} \end{aligned} \tag{3.5}$$

where λ_t is the multiplier associated with the liquidity constraint. The income shock is a combination of rural and urban income shocks if $0 < z_t < 1$. The current value of assets and income equals the maximum of current utility from consumption plus the discounted value of future assets and income. Maximization yields:

$$u'(c_t) = \beta E_t V'_{t+1}[(1 + r_t)(A_t + y_t - c_t) + y(z_t, \epsilon_{t+1}, \eta_{t+1})] + \lambda_t \tag{3.6}$$

The household also chooses the location one period before as a form of ex-ante risk insurance. Using the envelop theorem we have:

$$E_{t-1} \frac{dV'_t(\cdot)}{dz_{t-1}} = E_{t-1} u'(c_t) \frac{\partial y}{\partial z_{t-1}} = 0 \tag{3.7}$$

$$\iff E_{t-1}[\beta(1 + r) V'_{t+1}(\cdot) + \lambda_t] \frac{\partial y}{\partial z_{t-1}} = 0 \tag{3.8}$$

If the liquidity constraint 3.1 never binds ($\lambda_t = 0$), the location is chosen such that there is no incentive to move:

$$E_{t-1} V'_{t+1}(\cdot) \frac{\partial y}{\partial z_{t-1}} = 0 \tag{3.9}$$

but if it does bind and $\lambda_t > 0$ households chose z_{t-1} such that (rewriting eq. 3.8)

$$E_{t-1} \beta(1 + r) V'_{t+1}(\cdot) \frac{\partial y}{\partial z_{t-1}} = -E_{t-1} \lambda_t \frac{\partial y}{\partial z_{t-1}} \gtreqless 0 \tag{3.10}$$

The last inequality holds only when the liquidity constraint binds, which is when either shock is negative (meaning smaller than 1) but not equal to each other. We look at the short run effects of large shocks rather than the long run effects when shocks are expected to be at their mean of 1. Volatility is then interpreted as a higher chance of receiving a shock that is so large that all savings are wiped out. Households want to avoid being put in that situation. If most family members live and work in the rural area and the shock is sufficiently bad ($\epsilon_t << 1$) such that the liquidity constraint binds we have that $\partial y / \partial z_{t-1} > 0$. Households could then improve utility by moving some family members to the city: $-E_{t-1}\lambda_t \frac{\partial y}{\partial z_{t-1}} < 0$. Conversely, if z_{t-1} is closer to one (a higher share of family members in the urban sector) and $\eta_t << 1$ (bad urban year) we have that $\partial y / \partial z_{t-1} < 0$ and thus that $-E_{t-1}\lambda_t \frac{\partial y}{\partial z_{t-1}} > 0$. In that case the rural sector would be better if households expect the constraint to bind. If both shocks are of equal size they cancel, and we are back in the situation of equation 3.9 where there is no incentive to move.

Four insights arise: the more likely it is that the liquidity constraint binds, the more likely households will be able to improve consumption and utility by letting family members migrate to the area where they expect shocks to be smaller. Secondly, if the variance of shocks to the rural sector is larger than the variance of shocks to the urban sector, then rural households are more likely to suffer an adverse shock that is large enough to hit the liquidity constraint. This increases pressure to let family members migrate to the urban area. Without modern sector job growth this leads to an increase in the informal sector (for given wages) and a lower expected urban wage, which is the balancing force. The government sector can cushion the urban area against shocks but may also provide a direct source of income. Thirdly, if both shocks are equal in size we have that $\partial y / \partial z_{t-1} = 0$. Then no improvement can be gained from migrating, even if households hit a liquidity constraint. This is the case if the covariance of both shocks equals 1. Lastly, higher cost of migration lower the attractiveness of cities because more of the expected flow of urban income has to be spent on migration.[14]

4 Estimating the effect of risk on urban growth

The risk and migration model holds for a representative household. Aggregating over all households implies that the growth rate of the rural population R equals natural rural population growth ΔR^n minus any rural to urban migration m: $\Delta R \equiv \log R_{t+1} - \log R_t = \Delta R^n - m$. Since growth of the total population P is a weighted function g of the growth rates of R and the urban population U, it follows that: $\Delta U = g^{-1}(\Delta P) - \Delta R^n + m$.

In equilibrium no families have any incentive to move ($\partial y / \partial z_{t-1} = 0$) and the rate of migration is zero. The national urban population U_{it} for country i and year t (five-year intervals) is then given by the the specification in levels in Davis and Henderson (2003) based on Brueckner (1990):

$$\log U_{it} = \delta_0 \log P_{it} + \delta_1 X_{it} + \gamma_i + e_{it} \tag{4.1}$$

The X_{it} include measures that should capture the country's state of development, rural-urban differences in public service provision, democracy and infrastructure which may affect migration costs, urban cost of living, and ideally measures of the expected urban and rural wages. The γ_i capture fixed unobserved country characteristics and the e_{it} is the error term.

However, we will not assume that countries are in equilibrium every 5 years and rather focus on changes when rural-urban migration $m \neq 0$. This happens when the expected rural and urban wages do not equal, and in risky periods when the liquidity constraint

[14] Without migration costs, risk averse households would move independently from liquidity constraints. Lower migration costs should induce more migration independently of shocks if they fall below the utility costs of risk. The premium a household would be willing to pay to get rid of risk depends on the functional form of utility, but is positive for risk averse households. In long-run equilibrium when shocks are of mean size and no one has an incentive to move this means that the cost of migration is equal to the risk premium.

binds. In that case $\partial y/\partial z_{t-1} \neq 0$. The core message is that risk is a strong destabilizing force which influences the speed of urbanization rather than the level. Volatile countries are not necessarily more or less urbanized, but volatile periods will induce more migration. Rural-urban migration is therefore a positive function of urban wages and rural risk, and a negative function of rural wages, migration costs and urban risk:

$$m_t = m(w_R\epsilon_t, w_U\eta_t, \kappa, \sigma_{\epsilon,t}, \sigma_{\eta,t}) \tag{4.2}$$

The main econometric model is therefore given by:

$$\begin{aligned}\log U_{i,t+1} - \log U_{i,t} = &\beta_0(\log P_{i,t+1} - \log P_{it}) + \beta_1 \log(U_{it}/P_{it}) \\ &+ \beta_2 X(w_R\epsilon, w_U\eta)_{it} + \beta_3\sigma_{\epsilon,it} + \beta_4\sigma_{\eta,it} + \gamma_i + e_{it}\end{aligned} \tag{4.3}$$

where the X_{it} also contain control variables such as the growth of the economy.[15] Overall growth in average GDP per capita captures economic development and the transition process from an agricultural to an industrial economy (including changes to the urban-rural wage gap if growth, as is often assumed, originates in cities). Positive economic growth will also mean that it is less likely that credit constraints bind. Changes in wage prospects can also be approximated by including separate growth rates of urban and rural sectors of the economy. We let w_U further depend on the size of government spending to capture the probability of obtaining public income. The initial urbanization rate (U_{it}/P_{it}) is included as a measure of the state of development (which is highly collinear with initial GDP per capita).[16] $\sigma_{\epsilon,it}$ and $\sigma_{\eta,it}$ denote the effect of rural and urban sector risk, which is measured as the standard deviation of yearly sector growth rates within a five-year period. We assume that households form expectations at the beginning of every period t on the

[15] Since we do not observe rural versus urban fertility we can only include overall population growth.

[16] This variable is an important control because it captures the size of the destination location as a share of total population. The higher it is, the more cities there are as migration destinations and the bigger and more diverse they are. Such countries tend to be more developed and have more stable economies and less rural-urban migration. It also mirrors the remaining pool of rural people which still have to decide to migrate or not: a higher level of urbanization means that, conditioning on overall population growth, less people are available to migrate so urban growth should be lower. Moreover, it allows urbanization to influence itself if past migration leads to lower cost of additional migration through network effects.

volatility between t and t+1, and decide to move or not at time t. Much of the cost of migration is related to distance, which is a fixed effect and captured by the γ_i. Lastly, since many of the variables change only slowly over time, we expect to find some degree of autocorrelation in the errors e_{it}.

In robustness tests we will also include an index of democracy and authoritarian rule (polity index), the state of infrastructure (road density), and a dummy for independence because rulers limited migration during colonialism. The change in average rainfall proxies for changes in agricultural productivity. Financial development (as proxied by domestic credit divided by GDP) captures the extent to which markets are complete and the degree to which households have access to financial services: the higher this number, the less likely credit constraints will ever bind, and the less volatility should affect urban growth. The panel structure of our data enables us to let all variables change over time and to control for country fixed effects. We observe the level of urbanization and thus urban population growth every 5 years, which we regress on level country characteristics at the start of the period and on changes which happen during the 5 year period. See appendix A for detailed variable definitions and their sources.

5 Dealing with endogeneity

By regressing urban population growth on the initial level of urbanization, we implicitly introduce an endogenous variable.[17] Equation 4.2 can equivalently be expressed as

$$\log U_{t+1} = (1 - \beta_1) \log U_t - (\beta_0 + \beta_1) \log P_t + \beta_0 \log P_{t+1} + ... + \gamma_i + e_{it} \tag{5.1}$$

Nickell (1981) showed that the coefficient $(1 - \beta_1)$ is in this case measured with bias in both OLS and FE regressions if initial urban population is correlated with the country

[17] This also occurs in Brueckner (1990) and Fay and Opal (2000) but is not addressed.

fixed effects. Taking first differences also does not eliminate this bias. Since fixed effects control for any other unobservable country characteristics that may influence urbanization, including the national classification of urban areas based on density, we expect this correlation to be non-zero. Furthermore, it may well be that institutional characteristics of countries have non-negligible separate effects on urban growth, such as through urban development policies, which at the same time correlate with urban-rural risk and government size. This means that several of the proposed explanatory variables may be correlated with the error term. However, if we are willing to accept that these variables are predetermined, meaning correlated with the contemporaneous (five-year period) and past error terms but uncorrelated with subsequent disturbances five years or more into the future, then lagged level equations of 5.1 provide suitable instruments for equation 5.1 in first differences (Arrelano and Bond, 1991). A prerequisite is that the panel is at least three periods long and the e_{it} must be serially uncorrelated (which can be tested). Economically, this implies for example that lagged risk predicts current risk (because institutions to lower risk develop only slowly), but only current risk drives migration within the contemporaneous five-year period. It is unlikely that past risk determines migration between five and 15 years into the future directly, nor should it be correlated with the unexplained part of future urban growth. Since the length of the panel is up to six periods of five years, the model is overidentified, which allows standard Sargan tests for exogeneity of the instruments.[18] GMM techniques provide efficient estimation of this system of equations.[19] A caveat is that β_1 is close to zero, implying that the level of urbanization is quite persistent. In that case, lagged levels are only weak instruments for changes in the urban population. Blundell and Bond (1998) suggested to use lagged first differenced equations as additional instruments under the assumption that $E[\Delta U_{i,t-1}(\gamma_i + e_{it})] = 0$ for $t = 3, 4, ..., T$, which can be tested

[18] Bowsher (2002) shows that Sargan tests can become weak if too many instruments are used. Although using as much information as possible benefits efficiency, Roodman (2006) proposes to use less instruments than the number of units of observation (countries).

[19] This approach, called difference GMM, was used by Davis and Henderson (2003).

with a difference-in-Sargan overidentification test; see Arellano and Bond (1991).[20] We will use the two-step version of this estimator which is robust to arbitrary heteroskedasticity and we apply Windmeijer's (2005) correction of the standard errors for (otherwise severe) finite sample bias (see also Roodman, 2006).[21] For some variables, such as rainfall and the year of independence, we can claim that they are external to the model. For all other variables, we will make the relatively weak assumption that they are predetermined and endogenous with respect to contemporaneous and past disturbances, resulting in a comprehensive specification, instrumented with several lags.

6 Panel evidence from 1970 to 2000

6.1 Urban growth and risk

The estimation results of equation 4.3 is presented in Table B.1. For a sample of 163 countries from 1970 to 2000, we find that volatility significantly affects urban population growth. This holds even after controlling for fixed country-specific unobservable covariates, and the level of development as captured by the initial level of urbanization, average growth rate of GDP per capita and population growth during the same period.[22] [23] As predicted by the model, periods of high rural risk induce more rural-urban migration leading to faster urban growth, while (urban) manufacturing risk has the opposite effect. Both these effects are more significant than the positive effect of national economic growth.[24] This

[20] Using time dummies, this assumption implies that the mean of $\ln U$ evolves over time in a common way, reflecting the observed general trend of urbanization.
[21] We refer to this method as system-GMM (SGMM).
[22] The errors are robust to heteroskedasticity and clustered by country because we find significant first order autocorrelation in the errors. The list of countries included in the (unbalanced) panel is provided in Table A.1. Small island nations did not bias the results.
[23] We also experimented with human capital as a proxy for technological growth as in Henderson and Wang (2007), but it was never significant. The difference may come from the fact that our sample is based on overall urbanization levels, while theirs is based on a sample of cities which had grown to a size of at least 100,000 inhabitants by the year 2000. It may be that technology only benefits 'star' cities: capitals or large agglomerations with sufficient agglomeration economies. Our result should be seen as complementary.
[24] Agricultural risk should have a stronger impact in periods of weak or negative economic growth: periods in which credit constraints are more likely binding. An interaction term between GDP/capita growth and

provides an explanation of continued urbanization even without economic growth. For example, Bolivia experienced a fast rate of urban growth of 4% per year during the 80s at a time when economic growth was on average -3.6% per year between 1980 and 1985. The standard deviation of agricultural growth was a massive 13.4%. Zimbabwe's cities were growing just as fast during the 90s even though the economy contracted by 3% per year: again agricultural risk was 18.6% (compared to manufacturing risk of 7.1%). Regression 2 tests the competing hypothesis that national government spending, mostly in cities, increased the expected income in urban areas: it has the expected significant positive impact on urban growth, although risk remains an important additional channel. The third column shows that the positive effect of agricultural risk is not only driven by positive shocks. [25]

6.2 Robustness to alternative specifications

Table B.2 provides several robustness tests. First of all, regression 4 controls for the effects of independence and change in the average level of rainfall to capture climate driven migration as in Barrios et al. (2006) but they are insignificant and do not change our results. Secondly, agricultural risk may be picking up the effect of shocks to rainfall. This is not borne out by regression 5, suggesting that risk is more likely due to price shocks rather than due to weather related supply shocks. Unstable government spending (related to resource dependent government revenues and failed and costly stabilization schemes) increases instability in the economy and has an additional positive effect on urban growth: it correlates positively with shocks to overall GDP (.56) and also positively with rural shocks (.27), while being uncorrelated with manufacturing shocks (.07). Also risk from national terms-of-trade shocks has no separate effect on urban growth. Thirdly, the

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agricultural risk was indeed negative, but insignificant.

[25] The sample is smaller because not every country-specific five-year period contained at least two positive growth rates to be able to calculate a standard deviation.

insignificant effect of economic growth may be captured more precisely by differentiating between rural versus urban economic growth: shown in column 6. Both have the expected sign (positive origin growth decreases migration to the destination area) but still turn out insignificant, suggesting that risk is the dominant force. Regression 7 additionally controls for road density to capture differences in access to cities (providing more means of trade and diversification and lower migration costs) and the polity index captures the degree of democracy. Davis and Henderson (2003) found negative effects of democracy on primacy (the largest city's share of the urban population). Financial development aims to capture the extend of credit provision and market completeness. None of these are significant. The latter is probably too crude and unable to measure the important differences between rural and urban areas. Data availability also limits the sample resulting in a noisier estimate of the effect of risk. Lastly, regression 8 explores the possibility that urban growth is driven by shocks to the terms-of-trade between rural and urban areas. Urban and rural price indices are unfortunately unavailable, so we proxy for terms-of-trade by assuming that all agricultural value added is used to buy manufactured products from cities. Rural versus urban terms-of-trade is then defined as the ratio of manufacturing over agricultural value added. However, shocks to this index do not have an effect on urban growth, while agricultural risk is still significant. The main message from these tests is that a model of rural-urban migration based on rural risk provides an important and empirically significant additional explanation for fast urban growth.

6.3 Correcting for endogeneity

The bias introduced by the endogenous lagged dependent variable has the property that it is bounded by the OLS and FE estimators (Bond, 2002). Table B.3 therefore starts with an OLS version of regression 5 (Table B.2), indicating that coefficient β_1 (log urban population share) should be between -0.217 and -0.073. The coefficient is close to zero (high persistence) requiring the use of system GMM as explained in section 5. Regression 5b uses lags three and more of the variables in levels as instruments for the equation in first differences and additional first differenced lags to deal with the weakness of lagged urbanization levels as instruments for changes in urbanziation.[26] The Hansen J-statistic (robust to heteroskedasticity) cannot reject that the overall set of instruments is valid. Moreover, the difference-in-Sargan test cannot reject that the additional assumption needed for system GMM is valid as well. We conclude that β_1 equals -0.113. As a result, somewhat surprising, we find that the effect of rural risk is even larger: the coefficient has increased from about 0.1 to 0.4. A one standard deviation increase in rural risk leads to 3% more urban growth. Regressions 4b and 2b (reflecting 4 of Table B.2 and regression 2 of Table B.1) omit some of the insignificant control variables. Rural risk has a significant effect on urban growth (even when instrumented) which is more robust than the effect of national income per capita growth or government size. An economy with more risk seems to induce larger flows of migration towards cities. It is in cities that there lies hope of improving living conditions because they offer a more diverse demand for labor. More importantly, risk and large shocks may well force households to give up on the countryside if such shocks exhaust their buffer savings.

6.4 Regional perspective

The previous sections found the surprising result that national economic growth, capturing the transition from an agricultural to industry based economy, was insignificant in the pooled sample of countries. Table B.4 therefore runs the main empirical model separately for several regions: East-Asia and Pacific which urbanized fast at a time when industrialization took off in this region, and Sub-Saharan Africa and Latin America which also urbanized fast but without the economic miracle of East-Asia. Economic growth is clearly a driving force of urbanization in East-Asia as regression 9a shows. Government

[26] We use the third lag because the AR(2) test finds evidence of second order autocorrelation, which means that the second lag is unsuitable as an instrument. Formal tests of instrument strength such as in Stock and Yogo (2003) have not been developed yet for SGMM. The estimator uses many instruments while the interpretation of the size of F-tests on excluded instruments depends on the number of instruments used. Such tests are therefore not performed here. Note however that SGMM was designed to deal with the weak instrument problem posed by persistent regressors.

spending also aided urban development while periods of manufacturing volatility slowed rural-urban migration. The sharp contrast with Sub-Saharan Africa lies in the fact that (non-existent) economic growth hardly contributed to urbanization. Independence led to urban growth by lifting migration restrictions imposed by colonizers. Most importantly, rural risk appears to be an additional cause of urbanization in a region with very poorly developed insurance and credit markets, especially in rural areas. In Latin America the channel of risk is also present (after omitting the insignificant independence and rainfall variables), while the size of government did not play a role. In all cases urban growth is limited by manufacturing instability, as predicted by the model. The regional analysis shows that three main forces lead to urban growth, namely economic growth (the transition hypothesis), government involvement, and rural versus urban risk.

6.5 Natural resource export shocks

We found that rural-urban migration was not driven by changes or shocks to rainfall, suggesting that risk in the agricultural sector has more to do with price shocks than with supply shocks. Such price shocks may come from international prices for natural resources among which food price volatility is as high as the volatility of prices for ores and metals, as shown by Figure 2. Such world prices do not vary by country but since each country exports a different set of resources there is substantial variability in the exposure to such shocks across countries. If production of food and other natural resources is predominantly a rural activity then such price shocks may translate directly into rural risk. Sub-Saharan Africa and Latin America are very dependent on natural resource exports as shown by the descriptive statistics. To test this hypothesis we include natural resource export value volatility for four categories of resources: food products, agricultural raw materials (such as fertilizer), ores and metals, and fuels (including oil). Table B.5 shows fixed effects (10a) and SGMM (10b and 10c) regressions where agricultural value added volatility is replaced by resource export based measures of risk. The regressions show some evidence that food export volatility has a large and similar effect as agricultural value added volatility, but it is not robust to our instrumentation strategy in regressions 10b and 10c. Table B.6 takes a different perspective and investigates if natural resource export shocks help explain periods of high volatility in agricultural value added. Regressions 11 to 13 therefore regress our main regressor of interest on natural resource volatility, finding evidence that food export shocks driven by international price movements influence agricultural volatility and therefore rural risk. However, when we control for the influence of weather the sample size becomes smaller (due to data availability constraints) leading to an insignificant positive effect. For completeness, we also let manufacturing risk depend on resource export volatility because resource exports probably flow through ports in cities even though they are mostly produced in rural areas, suggesting that most of the effects of volatility are felt in cities. This is not the case as regressions 14 and 15 show. Manufacturing risk is influenced by government spending shocks, more significantly so than in the case of agricultural risk. However, these regressions can only explain a small share of the variation in agricultural and manufacturing risk and are therefore only suggestive. Value added based measures of sector and area risk seem to capture the mechanisms of the model more precisely.

7 Can the model explain the urbanization trend?

The stylized fact displayed by Figure 1, that countries can urbanize in the absence of urban job growth for continued periods of time, can be explained by the additional channel of risk-driven rural-urban migration. This begs the question if the (empirical) model can reproduce Figure 1 in an out of sample forecasting exercise. To do this, we ran again regression 4 of Table B.2 and regression 4b of Table B.3 four times, each time excluding one region and using the estimated coefficients to predict the path of urbanization for that region. The result is graphically displayed in Figure 3. The upper row shows the result for each region when using regression 4, while the lower row displays the results when applying the instrumentation strategy. The prediction works quite well. The latter estimator does a better job, showing the importance of correcting the bias introduced by the lagged dependent variable. The model underperforms somewhat for East Asia, but this can be explained by the regional regression 9a of Table B.4, which shows that the effect of economic growth and industrialization has had a much stronger effect in East Asia than what was estimated for the pooled sample. Similarly, urbanization is somewhat underpredicted in Sub-Saharan Africa in 1980 because the effect of rural risk was much larger in that region.

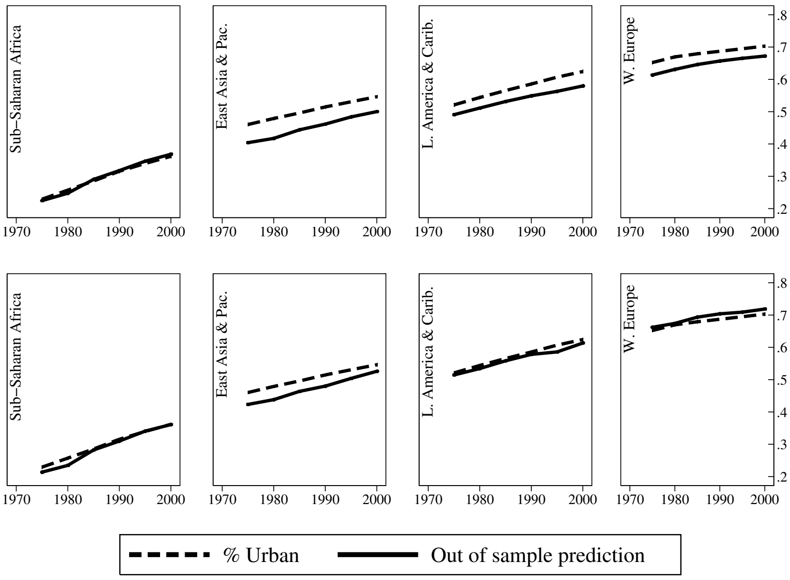

Fig. 3. Out of sample prediction (upper panel: reg. 4; lower panel: reg. 4b)

8 Conclusion

This paper addresses the fact that many countries urbanize surprisingly fast even though economic growth is slow or negative. Negative growth is unlikely to create urban jobs, it does not raise urban wages nor does it increase earlier migrants' flow of remittances, which could all be powerful urban-pull factors from the perspective of poor rural households. We solve this puzzle by acknowledging that push factors are at least as important, especially when the circumstances are such that households cannot cope with negative shocks to income. Periods of aggregate agricultural risk turn out to be strong predictors of urban growth. This channel stands up to alternative drivers of urban growth, such as government spending and economic growth. We cannot find evidence that changes to rainfall affect migration and urban growth and we find suggestive evidence that mainly price shocks are behind periods of high volatility. Aggregate risk may be more important than a sectoral shift from agriculture to manufacturing and the parallel transition to urbanization for countries with poor economic performance. Unable to save or insure effectively, households are forced to migrate to cities to avoid being hit by large negative shocks as an ex-ante response to expected risk, because large shocks may wipe out any buffer savings easily.

We realize that many countries with very large cities, and slums, view urbanization as a problem. If that is justified in itself then rural development of credit institutions could decrease migration pressure on cities. On the other hand, it might also be that agglomeration economies can bring opportunities to urbanizing countries if these centers can be made attractive enough for start-ups and foreign investment. Future research using micro data should shed more light on these issues.

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A Data Description and Sources

Category	Variable	Definition	Source
Population	urban population growth	5 year (ln) change in total urban population, national definition	UN (2005)
	log urban population share	ln (total urban population / total population)	idem
	av. national population growth rate	5 year average of yearly total population growth rates	WDI (2006)
GDP	average GDP/capita growth	5 year average of yearly GDP per capita growth rates (PPP, 2000 USD, Laspeyres)	PWT 6.2 from Heston et al. (2006)
Sectors	volatility of sector va growth	5 year volatility of yearly growth rate of total value added per sector. Value added (value of output less the value of intermediate consumption) of sector as a % of total value added. **Manufacturing**: section D Manufacturing. **Agriculture**: Section A Agriculture, hunting and forestry and Section B Fishing. **Mining**: Section C Mining and quarrying, Section E Electricity, gas and water supply. (all ISIC Rev 3.1)	United Nations Statistics Devision, (2007)
	av. growth sector va	5 year average of yearly growth rate of total value added per sector.	idem
Geography	% change in average rainfall	Change in ln average 5 year rainfall from last 5 year period.	Mitchell et al. (2002)
	volatility of rainfall	5 year standard deviation of yearly rainfall data.	idem
	road density	Roads (km) / land (km2)	International Road Federation and WDI (2006)
Institutions	polity index	Index of autocracy (-10) to democracy (+10)	Marshall et al. (2007)
	independence index	dummy = 1 if a country is independent	CIA World Factbook (2007)
	financial development	Domestic credit to private sector (% of GDP)	WDI (2006)
Resources	export growth volatility	5 year standard deviation of yearly (ln) changes by export group. F.o.b. value of exports as a percentage of GDP. **Fuels** corresponds to SITC section 3 (mineral fuels). **Ores and Metals**: SITC divisions 27, 28, and 68 (nonferrous metals). **Agricultural Raw Materials**: SITC section: 2 (crude materials except fuels) excluding divisions 22, 27 (crude fertilizers and minerals excluding coal, petroleum, and precious stones), and 28 (metalliferous ores and scrap). **Foods**: SITC sections: 0 (food and live animals), 1 (beverages and tobacco), and 4 (animal and vegetable oils and fats) and SITC division 22 (oil seeds, oil nuts, and oil kernels). (constant USD)	WDI (2006)
	price indices	yearly standard deviation of monthly price changes	UNCTAD (2007)
Other	volatility of government spending	5 year standard deviation of yearly (ln) changes in government spending	PWT 6.2 from Heston et al. (2006)
	volatility in terms-of-trade	5 year standard deviation of yearly imports share of exports	WDI (2006)

Table A.1
Countries included in sample of B.1

Afghanistan	Comoros	Hong Kong, China	Mongolia	Slovenia
Algeria	Congo, Dem. Rep.	Hungary	Morocco	Solomon Islands
Antigua and Barbuda	Congo, Rep.	Iceland	Mozambique	Somalia
Argentina	Costa Rica	India	Namibia	South Africa
Armenia	Cote d'Ivoire	Indonesia	Nepal	Spain
Australia	Croatia	Iran, Islamic Rep.	Netherlands	Sri Lanka
Austria	Cuba	Iraq	Netherlands Antilles	Sudan
Azerbaijan	Cyprus	Ireland	New Zealand	Suriname
Bahrain	Czech Republic	Israel	Nicaragua	Swaziland
Bangladesh	Denmark	Italy	Niger	Sweden
Barbados	Djibouti	Jamaica	Nigeria	Switzerland
Belarus	Dominica	Japan	Norway	Tajikistan
Belgium	Dominican Republic	Jordan	Oman	Tanzania
Belize	Ecuador	Kazakhstan	Pakistan	Thailand
Benin	Egypt, Arab Rep.	Kenya	Palau	Togo
Bermuda	El Salvador	Kiribati	Panama	Tonga
Bhutan	Equatorial Guinea	Korea, Rep.	Papua New Guinea	Trinidad and Tobago
Bolivia	Estonia	Kuwait	Paraguay	Tunisia
Bosnia and Herzegovina	Ethiopia	Latvia	Peru	Turkey
Botswana	Fiji	Lebanon	Philippines	Turkmenistan
Brazil	Finland	Lesotho	Poland	Uganda
Bulgaria	France	Liberia	Portugal	Ukraine
Burkina Faso	Gabon	Lithuania	Puerto Rico	United Arab Emirates
Burundi	Gambia, The	Luxembourg	Qatar	United Kingdom
Cambodia	Georgia	Madagascar	Romania	United States
Cameroon	Germany	Malawi	Russian Federation	Uruguay
Canada	Ghana	Malaysia	Rwanda	Uzbekistan
Cape Verde	Greece	Maldives	Samoa	Vanuatu
Central African Republic	Grenada	Mali	Sao Tome and Principe	Venezuela, RB
Chad	Guatemala	Malta	Saudi Arabia	Zambia
Chile	Guinea	Mauritania	Senegal	Zimbabwe
China	Haiti	Mauritius	Sierra Leone	
Colombia	Honduras	Mexico	Singapore	

B Regression tables

Table B.1
Urban growth and volatility, 1970-2000

Dependent variable:	(1: FE)	(2: FE)	(3: FE)
5-year urban population growth			
volatility of agri. va growth	0.079**	0.082**	
	(0.037)	(0.040)	
volatility of positive agricultural shocks			0.110
			(0.069)
volatility of manuf. va growth	-0.003***	-0.002***	0.001
	(0.000)	(0.000)	(0.008)
log urban population share	-0.218***	-0.223***	-0.226***
	(0.029)	(0.029)	(0.030)
Average GDP/capita growth	0.096*	0.082	0.062
	(0.053)	(0.057)	(0.060)
av. national population growth rate	1.087***	1.091***	1.092***
	(0.036)	(0.037)	(0.038)
government share of GDP		0.118**	0.128**
		(0.051)	(0.054)
Constant	-0.145***	-0.176***	-0.181***
	(0.028)	(0.031)	(0.032)
Observations	898	889	826
Adjusted R-squared	0.647	0.647	0.657
Countries	163	163	161

Robust and country-clustered standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.2
Robustness to alternative explanations

Dependent variable: **5-year urban population growth**	(4: FE)	(5: FE)	(6: FE)	(7: FE)	(8: FE)
volatility of agri. va growth	0.087**	0.107**	0.113**	0.093	0.141**
	(0.040)	(0.050)	(0.052)	(0.082)	(0.064)
volatility of manuf. va growth	-0.002***	-0.002***	0.010	0.062	0.053
	(0.001)	(0.001)	(0.019)	(0.102)	(0.059)
log urban population share	-0.226***	-0.217***	-0.217***	-0.215***	-0.217***
	(0.030)	(0.035)	(0.036)	(0.058)	(0.035)
Average GDP/capita growth	0.066	0.076			
	(0.055)	(0.073)			
av. growth agri. va			-0.028	0.008	-0.045
			(0.054)	(0.073)	(0.050)
av. growth manuf. va			0.027	0.173*	0.020
			(0.040)	(0.093)	(0.041)
av. national population growth rate	1.096***	1.109***	1.108***	1.329***	1.109***
	(0.035)	(0.057)	(0.049)	(0.118)	(0.050)
government share of GDP	0.107**	0.124**	0.129**	0.087	0.127**
	(0.050)	(0.058)	(0.058)	(0.090)	(0.058)
independence index	0.019	0.010	0.011	0.047***	0.014
	(0.013)	(0.014)	(0.015)	(0.011)	(0.016)
change in average rainfall	-0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
volatility of rainfall		-0.000	-0.000	0.000	-0.000
		(0.000)	(0.000)	(0.000)	(0.000)
volatility of government spending		0.064**	0.061**	0.098***	0.056*
		(0.029)	(0.028)	(0.037)	(0.029)
volatility in ToT (imp/exp)		0.005	0.004	-0.007	0.004
		(0.012)	(0.011)	(0.037)	(0.011)
financial development				0.003	
				(0.016)	
road density				0.048	
				(0.036)	
polity index				0.000	
				(0.001)	
volatility in ToT (manuf./agri. va)					-0.041
					(0.054)
Constant	-0.193***	-0.183***	-0.184***	-0.263***	-0.186***
	(0.037)	(0.039)	(0.040)	(0.051)	(0.041)
Observations	883	775	775	511	775
Adjusted R-squared	0.656	0.631	0.630	0.524	0.631
Countries	162	158	158	117	158

Robust and country-clustered standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table B.3
Robustness: dealing with endogeneity

Dependent variable:	(5a: OLS)	(5b: SGMM)	(4b: SGMM)	(2b: SGMM)
5-year urban population growth				
volatility of agri. va growth	0.124**	0.384**	0.304**	0.305**
	(0.059)	(0.180)	(0.151)	(0.142)
volatility of manuf. va growth	0.002**	0.024	0.037	0.040
	(0.001)	(0.032)	(0.038)	(0.040)
log urban population share	*-0.073****	*-0.113****	*-0.123****	*-0.120****
	(0.009)	*(0.018)*	*(0.022)*	*(0.019)*
av. national population growth rate	1.154***	1.189***	1.076***	1.092***
	(0.100)	(0.149)	(0.112)	(0.114)
Average GDP/capita growth	0.139	0.025	-0.113	-0.118
	(0.138)	(0.236)	(0.171)	(0.177)
volatility of rainfall	-0.000	-0.000		
	(0.000)	(0.000)		
volatility of government spending	0.080**	0.021		
	(0.037)	(0.079)		
volatility in ToT (imp/exp)	-0.000	-0.023		
	(0.010)	(0.036)		
government share of GDP	-0.088*	-0.139	-0.140	-0.134
	(0.047)	(0.132)	(0.123)	(0.129)
independence index	0.009	0.014	0.002	
	(0.013)	(0.017)	(0.013)	
change in average rainfall	-0.000	-0.000	-0.000	
	(0.000)	(0.000)	(0.000)	
Constant	0.012	-0.063*	-0.043*	-0.043*
	(0.019)	(0.038)	(0.022)	(0.025)
Observations	775	775	883	889
Adjusted R-squared	0.718			
countries	158	158	162	163
Instruments		98	70	68
AR(2) (p-value)		0.048	0.011	0.007
AR(3) (p-value)		0.125	0.121	0.280
Hansen J-stat. overid. (p-value)		0.299	0.326	0.443
Difference-in-Sargan (p-value)		0.383	0.263	0.444

Robust (and country-clustered in 4a) standard errors in parentheses. Time dummies included. SGMM refers to twostep System-GMM (Blundell and Bond, 1998) which is robust to arbitrary heteroskedasticity. The independence dummy and change in rainfall are assumed to be exogenous whereas other regressors are assumed to be predetermined (uncorrelated with current and future errors).

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

Table B.4
Results by region

Dependent variable:	(9a: FE)	(9b: FE)	(9c: FE)	(9d: FE)
5-year urban population growth	EAP	SSA	LAC	LAC
volatility of agri. va growth	0.133	0.188**	0.117	0.124*
	(0.095)	(0.085)	(0.072)	(0.067)
volatility of manuf. va growth	-0.115*	-0.003***	-0.105**	-0.098**
	(0.063)	(0.001)	(0.045)	(0.045)
Average GDP/capita growth	0.272**	0.037	0.055	0.032
	(0.115)	(0.096)	(0.096)	(0.113)
log urban population share	-0.062	-0.260***	-0.123**	-0.132***
	(0.051)	(0.041)	(0.045)	(0.048)
av. national population growth rate	1.000***	1.188***	0.928***	0.914***
	(0.194)	(0.064)	(0.257)	(0.243)
independence index	-0.028	0.073***	-0.019	
	(0.036)	(0.022)	(0.025)	
change in average rainfall	0.000	0.000	-0.000	
	(0.000)	(0.000)	(0.000)	
government share of GDP	0.475**	0.295***	0.041	0.040
	(0.220)	(0.105)	(0.026)	(0.024)
Constant	-0.076	-0.420***	-0.022	-0.044
	(0.068)	(0.082)	(0.030)	(0.031)
Observations	117	262	186	186
Adjusted R-squared	0.459	0.596	0.434	0.433
Countries	20	44	31	31

Robust and country-clustered standard errors in parentheses. EAP = East Asia and Pacific; SSA = Sub-Saharan Africa; LAC = Latin America and Caribbean. World Bank definition.

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

Table B.5
Urban growth and resource export revenue shocks

Dependent variable: **5-year urban population growth**	(10a: FE)	(10b: SGMM)	(10c: SGMM)
food export growth volatility	0.793**	1.184	0.901
	(0.378)	(0.882)	(0.826)
agr. r.m. export growth volatility	-0.169	-0.568*	-0.149
	(0.183)	(0.344)	(0.455)
ores export growth volatility	0.061	0.202	0.002
	(0.117)	(0.164)	(0.113)
fuel export growth volatility	0.022	-0.068	0.059
	(0.098)	(0.207)	(0.190)
volatility of manuf. va growth	-0.027	-0.151	-0.121
	(0.055)	(0.121)	(0.097)
log urban population share	-0.243***	-0.073***	-0.080***
	(0.036)	(0.017)	(0.017)
Average GDP/capita growth	0.026	0.371	0.445*
	(0.089)	(0.253)	(0.245)
av. national population growth rate	1.006***	1.304***	1.236***
	(0.055)	(0.139)	(0.146)
volatility of rainfall	-0.000	0.000	
	(0.000)	(0.000)	
volatility of government spending	-0.098*	0.012	
	(0.052)	(0.120)	
volatility in ToT (imp/exp)	-0.056**	0.001	
	(0.022)	(0.044)	
government share of GDP	0.160**	0.047	0.033
	(0.070)	(0.091)	(0.082)
independence index	-0.033	0.003	0.014
	(0.030)	(0.015)	(0.022)
change in average rainfall	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Constant	-0.117***	-0.049*	-0.061**
	(0.040)	(0.027)	(0.028)
Observations	532	532	549
Adjusted R-squared	0.700		
Countries	132	132	137
Instruments		124	96
AR(2) (p-value)		0.048	0.018
AR(3) (p-value)		0.335	0.253
Hansen J-stat. overid. (p-value)		0.352	0.615
Difference-in-Sargan (p-value)		0.406	0.623

Robust (and country-clustered in 10a) standard errors in parentheses. Time dummies included. SGMM refers to twostep System-GMM (Blundell and Bond, 1998) which is robust to arbitrary heteroskedasticity. The independence dummy and change in rainfall are assumed to be exogenous whereas other regressors are assumed to be predetermined (uncorrelated with current and future errors).

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

Table B.6
Urban growth and resource export revenue shocks

Dependent variable:	(11: FE) σ_{agri}	(12: FE) σ_{agri}	(13: FE) σ_{agri}	(14: FE) σ_{manuf}	(15: FE) σ_{manuf}
food export growth volatility	0.946***	0.955***	1.018	0.123	0.133
	(0.338)	(0.353)	(0.874)	(0.449)	(0.403)
agr. r.m. export growth volatility	-0.263*	-0.242	-0.274	0.267	0.055
	(0.140)	(0.158)	(0.249)	(0.179)	(0.148)
ores export growth volatility	-0.063	-0.019	0.042	0.100	0.139
	(0.100)	(0.077)	(0.090)	(0.112)	(0.125)
fuel export growth volatility	-0.019	-0.032	-0.032	-0.001	0.011
	(0.034)	(0.037)	(0.050)	(0.051)	(0.049)
volatility of government spending		0.113*	0.105		0.104**
		(0.067)	(0.098)		(0.041)
financial development		-0.007	0.001		-0.013*
		(0.013)	(0.019)		(0.007)
change in average rainfall			-0.000*		
			(0.000)		
volatility of rainfall			0.000		
			(0.000)		
Constant	0.070***	0.062***	0.059***	0.054***	0.053***
	(0.006)	(0.009)	(0.014)	(0.005)	(0.006)
Observations	684	647	528	676	639
Adjusted R-squared	0.028	0.046	0.033	0.016	0.024
Countries	147	139	134	145	137

Robust and country-clustered standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$