The Agricultural Productivity Gap in Developing Countries

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Background

- In much of sub-Saharan Africa (and in many of the world's poorest countries), large fractions of the population live in rural areas and work in quasi-subsistence agriculture.
- Productivity levels in this sector appear to be very low – both in absolute terms and relative to the non-agricultural sector.
- By contrast, in rich countries, productivity appears to be approximately equal across sectors.
- Ricardian comparative advantage suggests that countries should specialize in sectors that are relatively most productive, compared to the rest of the world.
- Why are so many people in poor countries working in a sector where they appear to be relatively so unproductive?

Related Literature

- A large body of recent literature that examines growth through the lens of structural transformation.
- Gollin, Parente, and Rogerson (2004) documented large differences in sectoral productivity in developing countries.
- Caselli (2005), in *Handbook of Economic Growth,* shows that low sectoral productivity in agriculture is an important proximate source of income differences across countries.
- Vollrath (2008, 2012, etc.) suggests that allocative inefficiency across sectors may be important.
- Herrendorf and Schoellman (2012) express reasons for concern about measurement: large differences in average productivity in agriculture across US states.

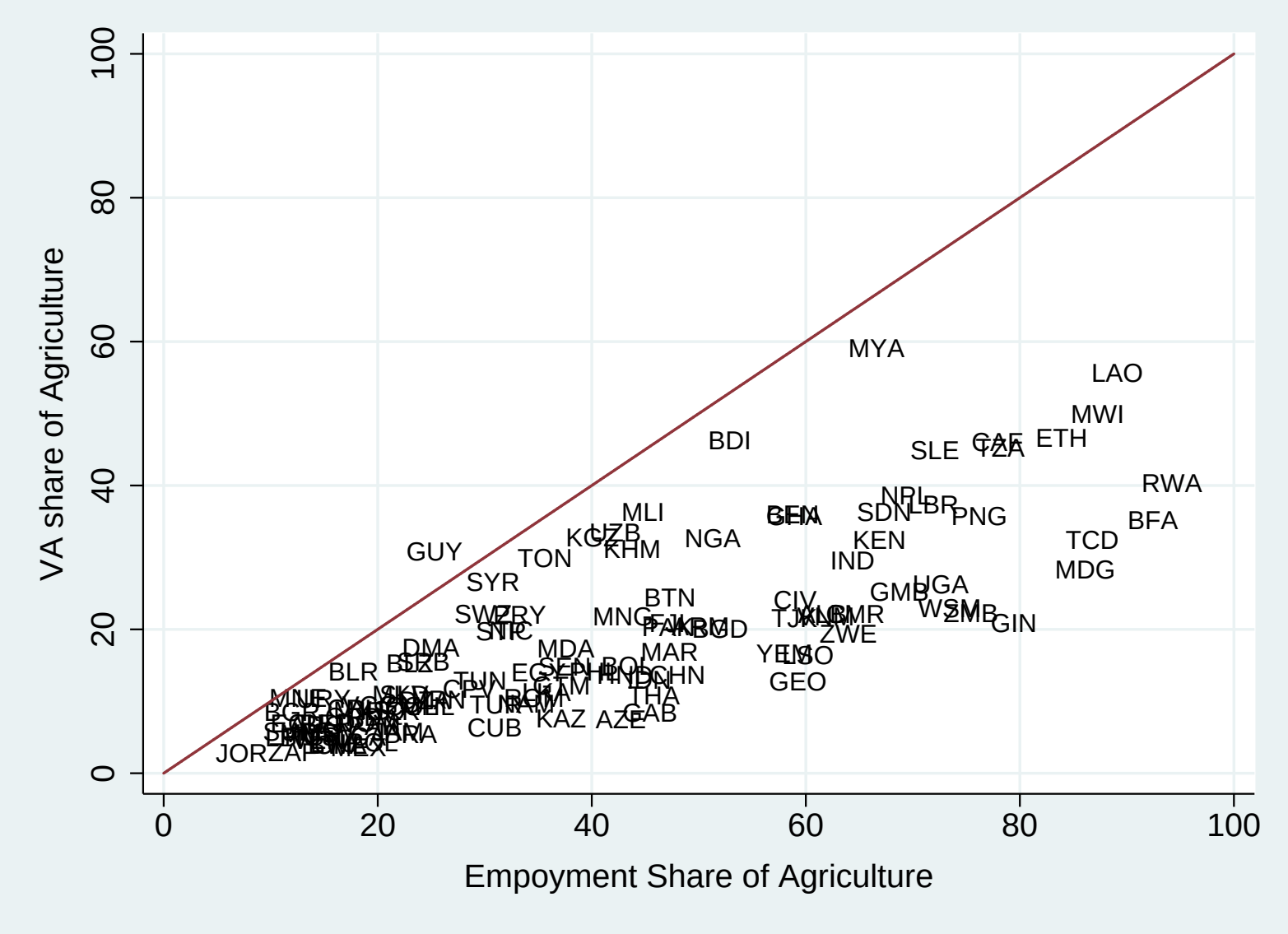
Does Mismeasurement Explain the Puzzle?

- One view is that we simply cannot believe the data.
- This paper attempts to measure the productivity gaps using the best available theory and data.
  - Are sectoral productivity differences merely illusory?
  - Can we improve measurement of productivity differences?
  - Do unexplained differences remain?

Agriculture Sector in Developing Countries

- Agriculture's share of employment high
- Share of value added *systematically lower* than share of employment

Agriculture Sector in Developing Countries



Agriculture Sector in Developing Countries

- Agriculture's share of employment high
- Share of value added *systematically lower* than share of employment
- Implies that VA/L lower in agriculture than non-agricultural sector

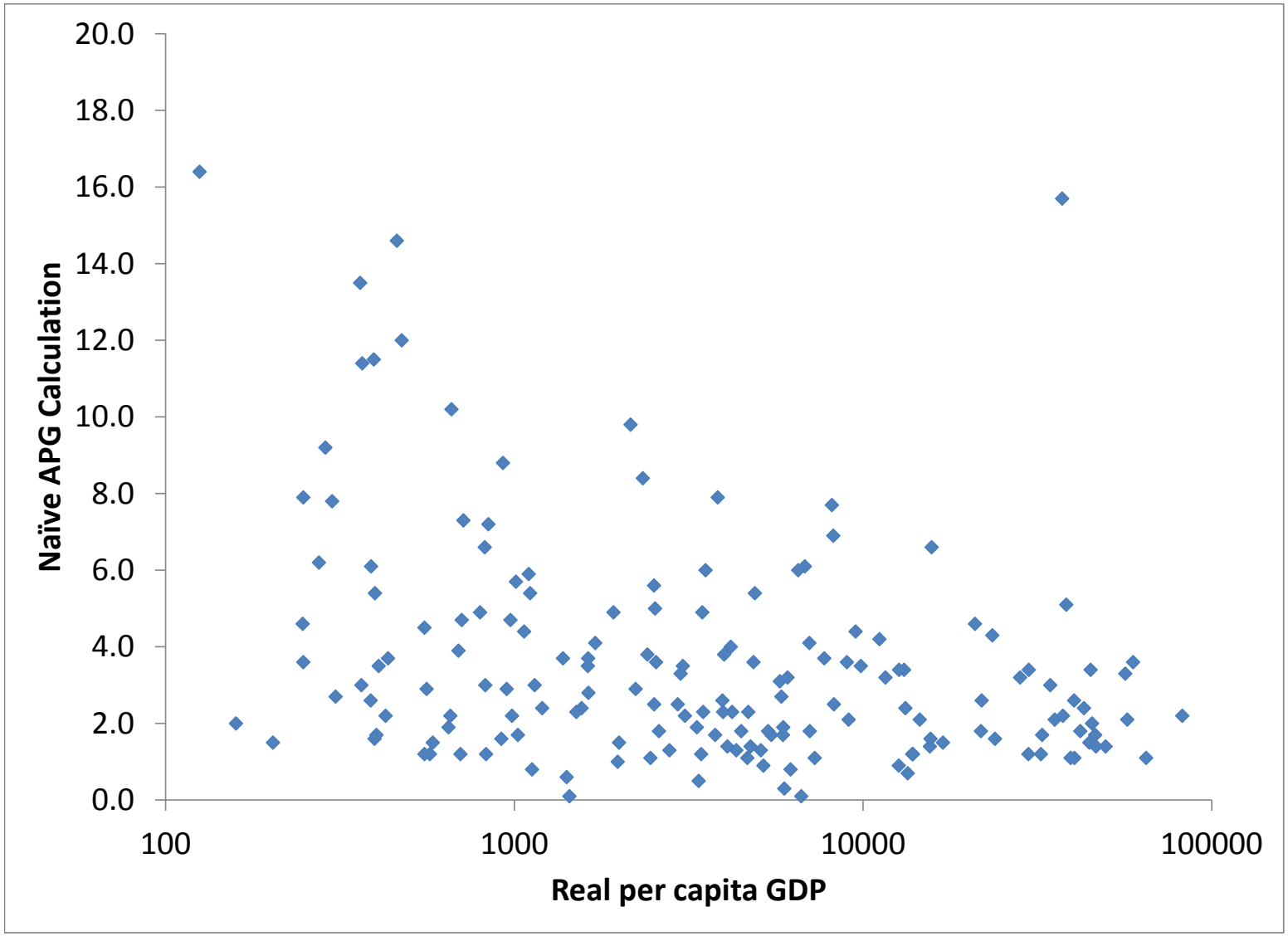
The Agricultural Productivity Gap in Developing Countries

- We define the Agricultural Productivity Gap (APG) to be:

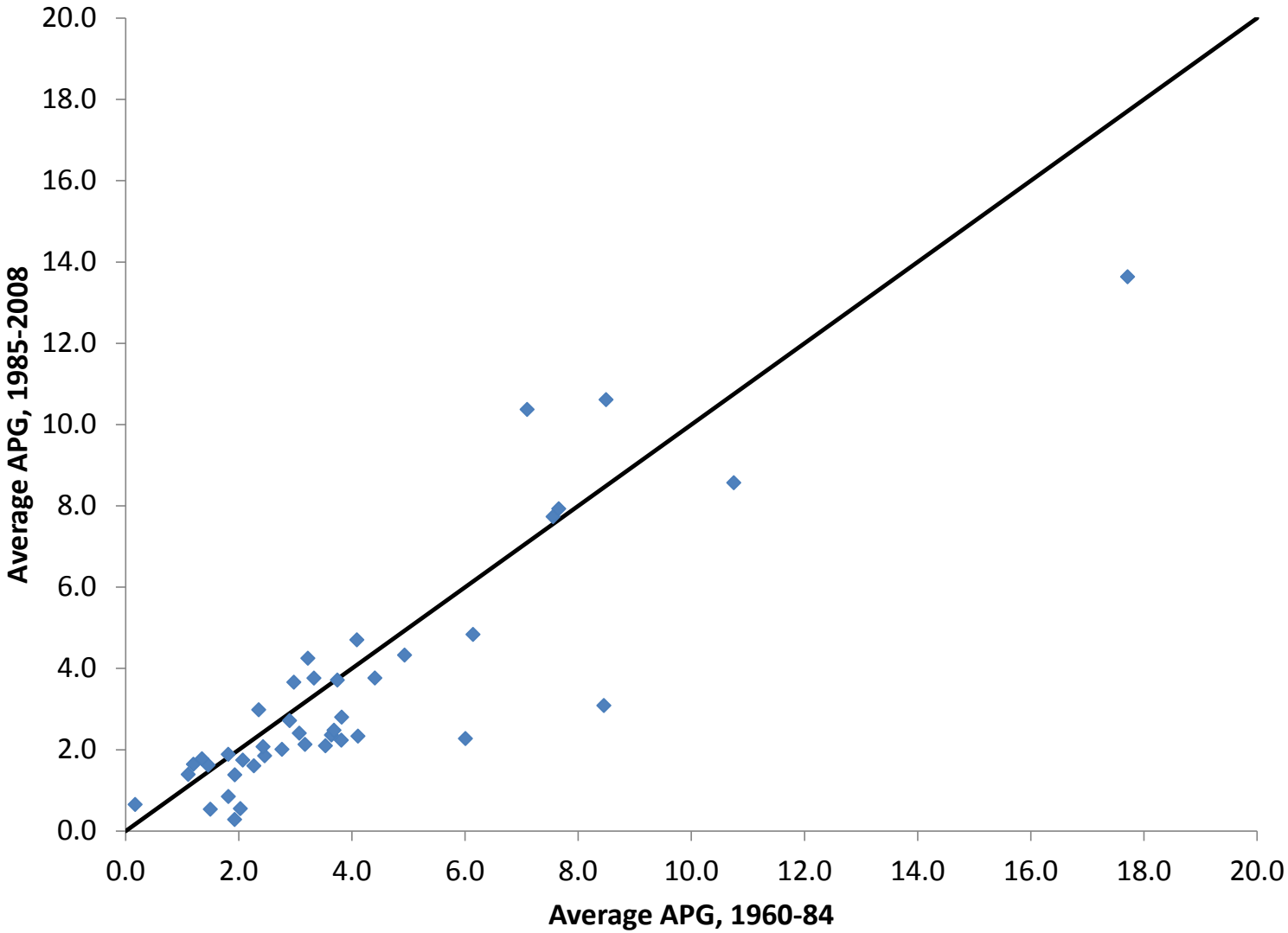
$$APG \equiv \frac{VA_n/L_n}{VA_a/L_a}.$$

- Under some moderately restrictive assumptions, APG should be close to 1; this is a useful benchmark.
- Typical developing country has APG of 4. Some have 8 or more!
- But can we trust these highly aggregate numbers?

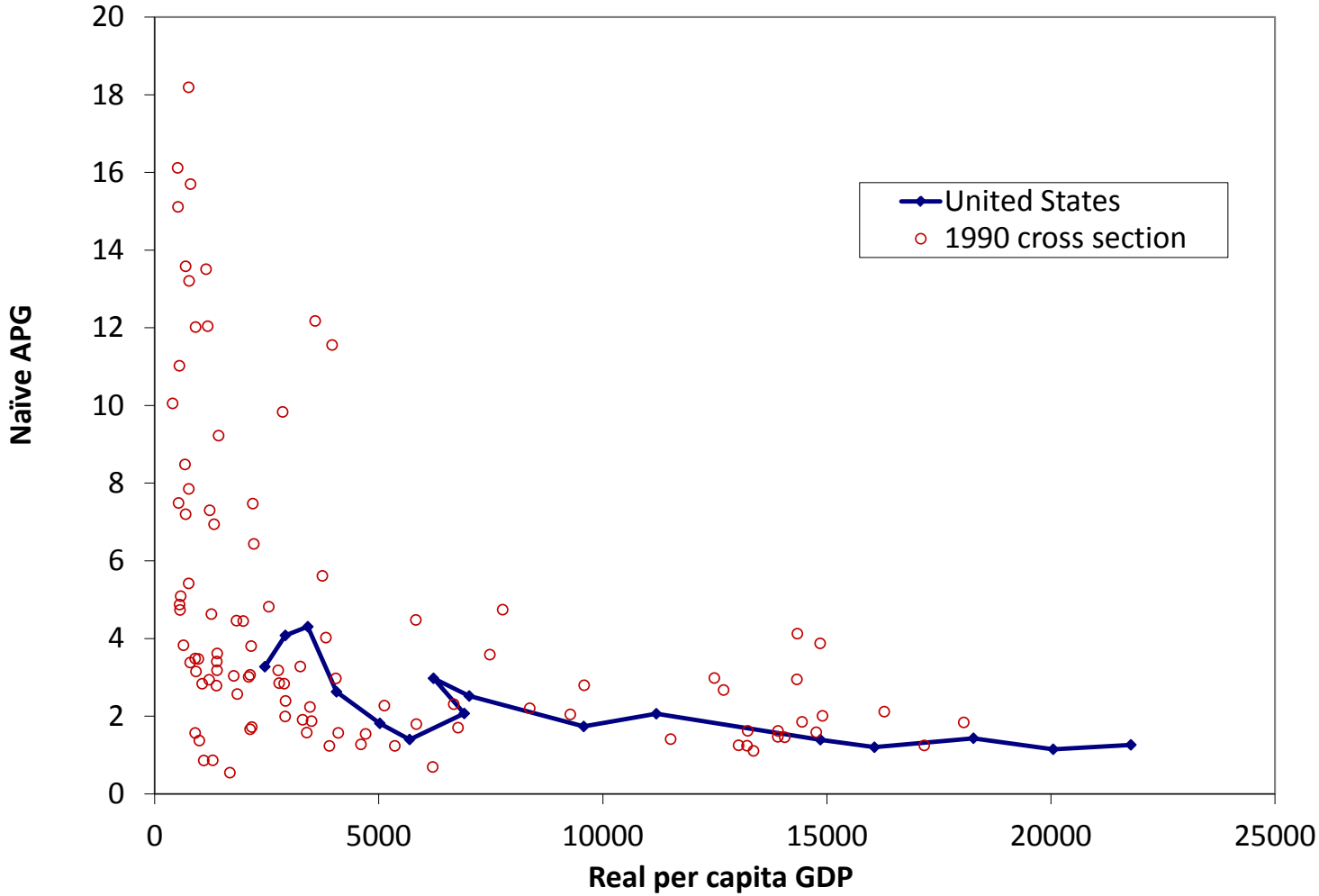
The Agricultural Productivity Gap in Developing Countries



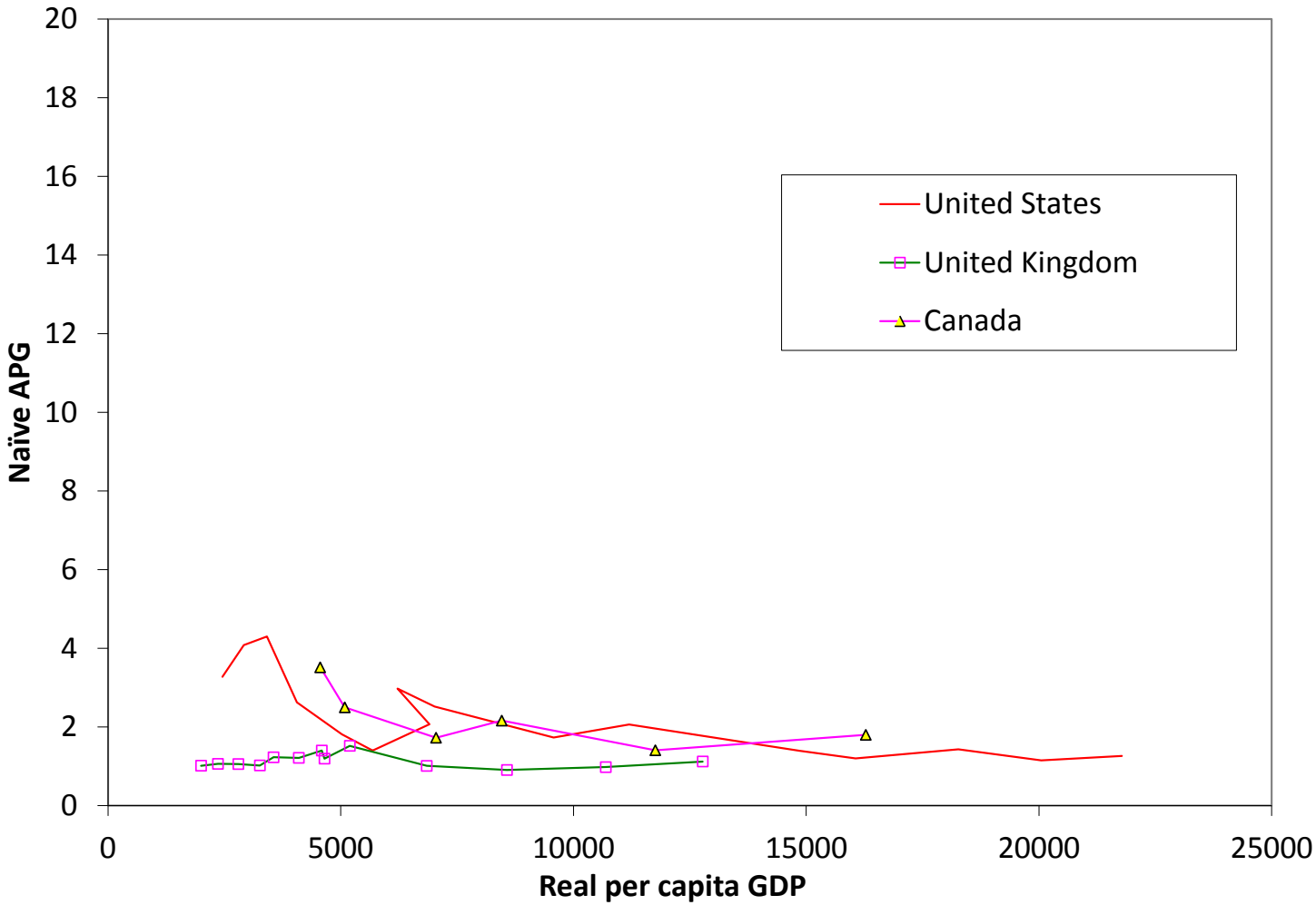
Agricultural Productivity Gaps over Time



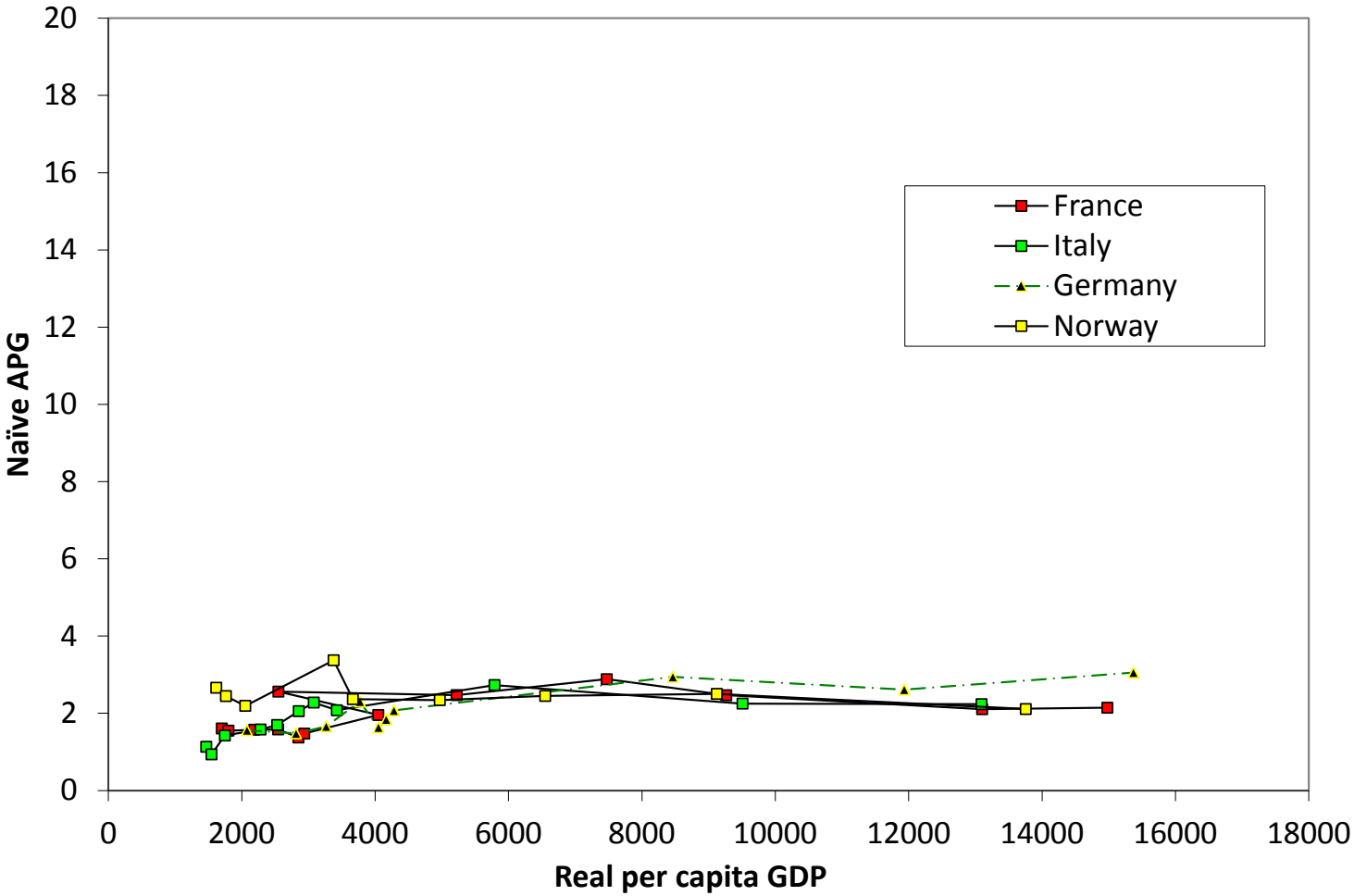
Naive APGs Relative to US Historical Data



Naive Historical APGs in US, UK, and Canada



Naive Historical APGs in France, Italy, Norway, and Germany



The Agricultural Productivity Gap in Developing Countries

- In a mechanical sense, the differences in sectoral productivity can "explain" a great deal of cross-country differences in GDP per worker. (Caselli, 2005; Restuccia et al, 2008; Vollrath, 2009)
- Taken at face value, gaps suggest **misallocation.**
- Policy debate: Encourage movement out of agriculture? Target agricultural sector for investments?
- This paper: refine the **measurement** of productivity gaps.

Possible Sources of Measurement Error

- Sector differences in hours worked per worker?

  Construct measures of hours worked by sector for 51 countries

- Sector differences in human capital per worker?

  Construct measures of human capital by sector for 98 countries

- Shortcomings of national accounts data?

  Use household income/expenditure surveys from 10+ countries

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Preview of Results

- After adjustments, APG in average developing country reduced from 4 to 2.
- Gaps are present in micro data as well as macro aggregates.
- Needed: better understanding of why residual gaps so large.

Simple Two-Sector Model

- Technologies:
  $Y_a = A_a L_a^{\theta} K_a^{1-\theta}$ and $Y_n = A_n L_n^{\theta} K_n^{1-\theta}$
- Households can supply labor to either sector.
- Competitive labor markets, i.e. workers paid their marginal product.
- Equilibrium: $\text{APG} \equiv \frac{VA_n/L_n}{VA_a/L_a} = \frac{Y_n/L_n}{p_a Y_a/L_a} = 1.$

Computing "Raw" Agricultural Productivity Gaps

- Measures of VA_a and VA_n.

  Value added as defined in 1993 System of National Accounts (SNA).

  Source: World Bank, via country national accounts data.

- Measures of L_a and L_n: "economically active population" by sector.

  Employed or unemployed persons who are working (or seeking work) in the production of some good or service recognized by the 1993 SNA.

  Source: World Bank, via population censuses or labor force surveys.

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Summary Statistics of Raw Agricultural Productivity Gaps

Measure	Weighted	Unweighted
5th Percentile	1.7	1.1
Median	3.7	3.0
Mean	4.0	3.6
95th Percentile	5.4	8.8
Number of Countries	113	113

"Simple" Measurement Error in National Accounts Data?

- Understate agricultural VA by excluding output produced for own consumption?

  No in principle: it is included as per SNA.

  No in practice: output of particular crop = area planted x yield

- Overstate agricultural employment, by including all rural persons?

  No in principle: only economically active persons included per SNA.

  No in practice: national accounts consistent with household surveys.

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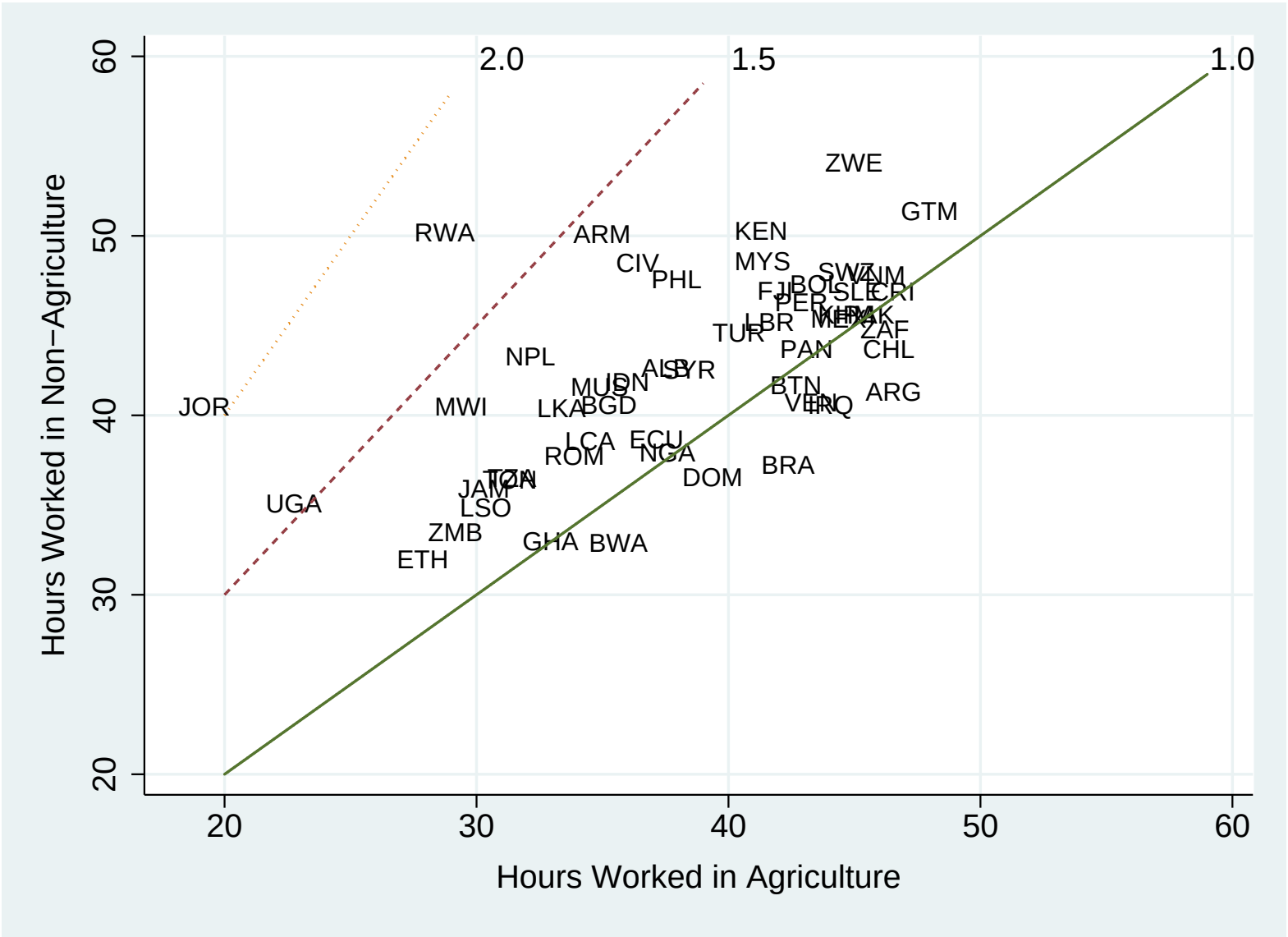
Sector Differences in Hours Worked

- Average hours worked per worker might differ across sectors.
- We construct average hours worked per worker by sector for 51 countries.
  - Population census micro data or labor force surveys.
  - All employed or unemployed persons 15+ years old.
  - Industry of primary employment (employed); industry of previous employment or rural/urban status (unemployed).
  - Hours worked in reference period (usually one week).

Sector Differences in Hours Worked



Sector Differences in Hours Worked: Summary

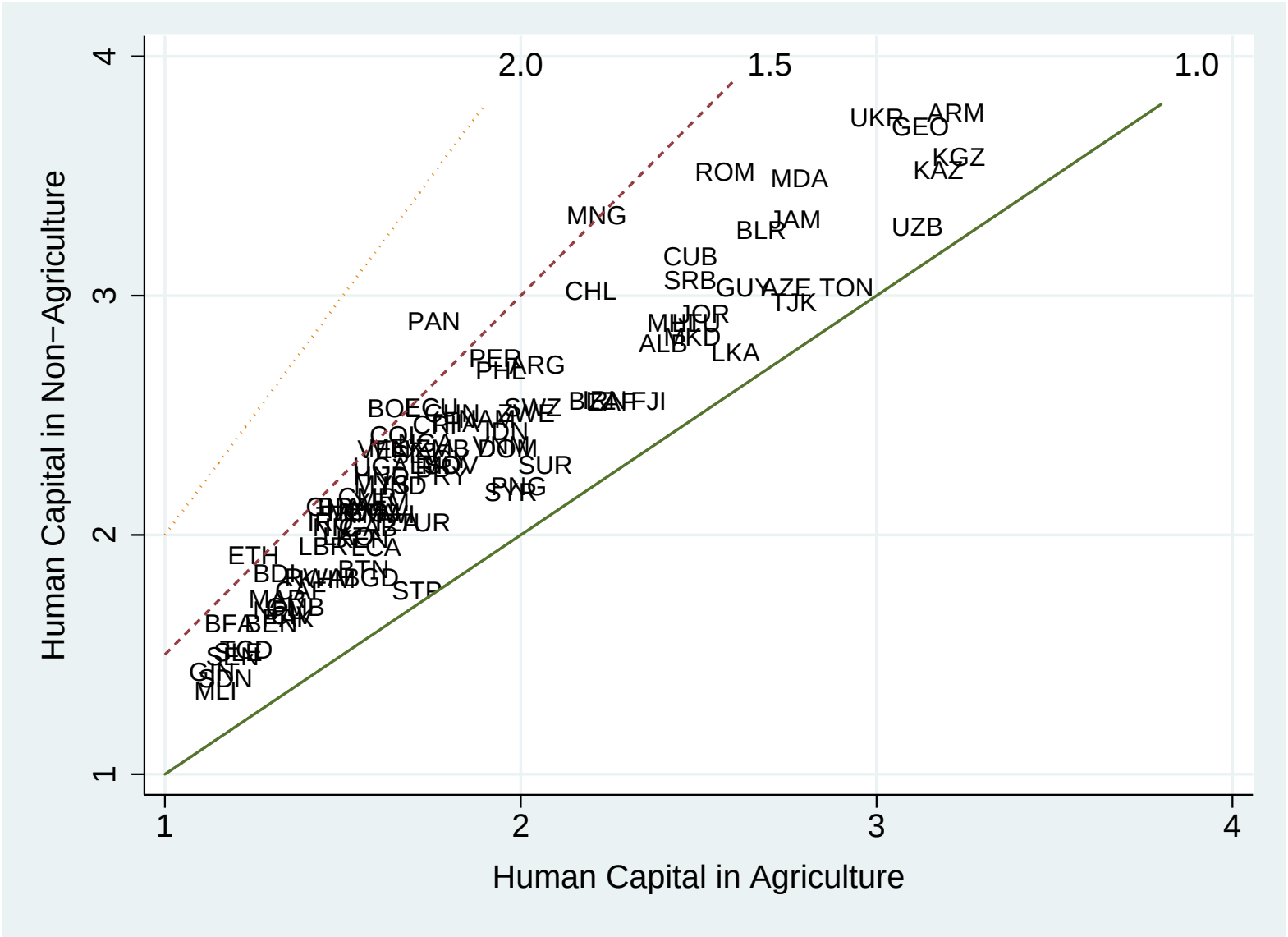
- Explains on average a factor 1.2.
- Only a few countries above 1.5.
- Unlikely to be the main cause of APGs in developing countries.

Sector Differences in Human Capital

- Average human capital per worker could differ across sectors. (Caselli & Coleman, 2001; Vollrath, 2009)
- We construct human capital per worker by sector for 97 countries.
  - Years of schooling measured directly when available.
  - Impute years of schooling using educational attainment otherwise.
  - Baseline: assume 10% rate of return on year of schooling. (Psacharoplous & Patrinos 2002; Banerjee & Duflo, 2005)

$$h_{j,i} = \exp(s_{j,i} \cdot 0.10)$$

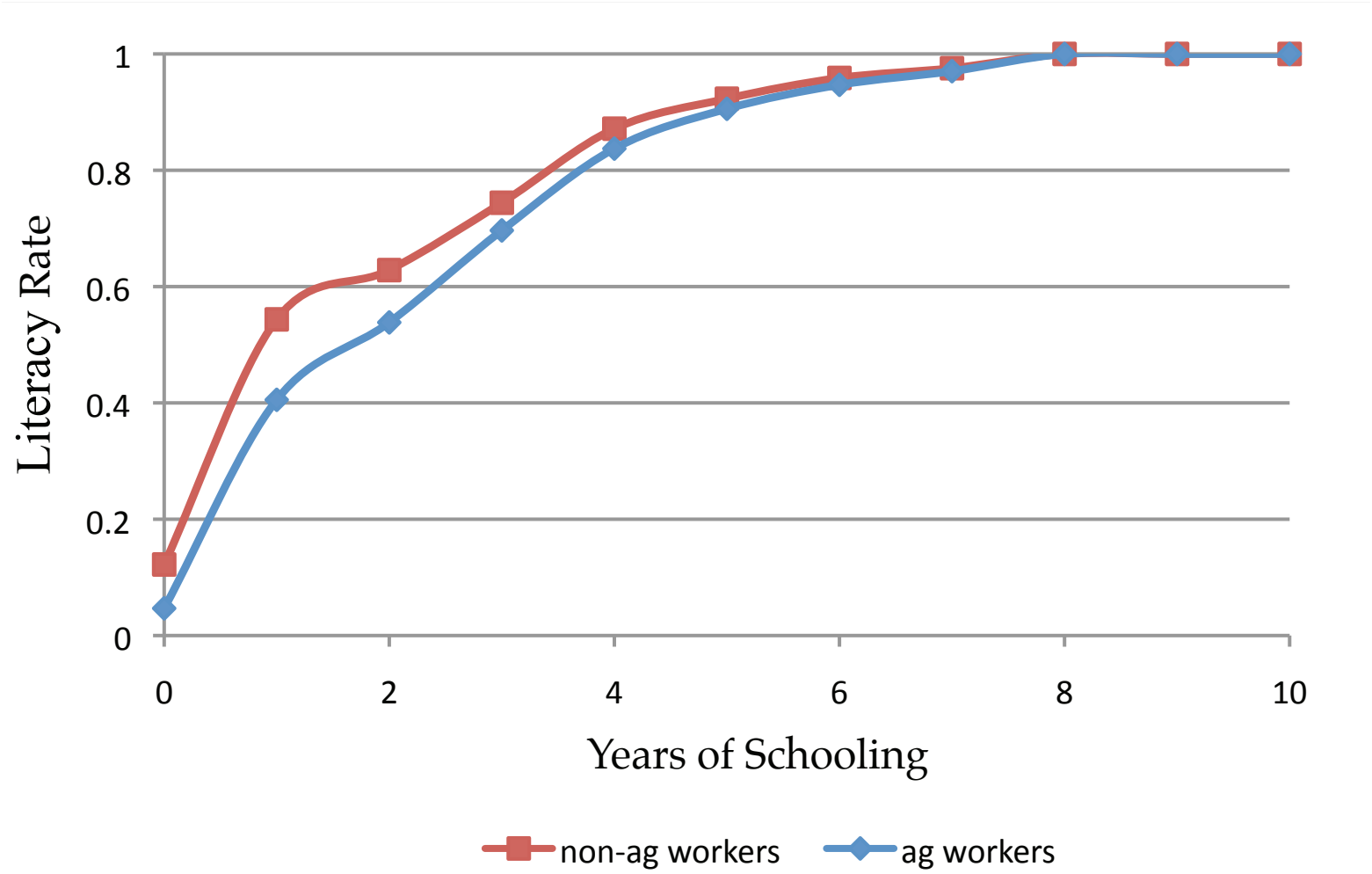
Sector Differences in Human Capital



Quality Differences in Schooling

- Rural schools often of lower quality than urban schools . (Williams, 2005; Zhang, 2006)
- Potentially *overestimate* human capital among agriculture workers.
- We use literacy data to adjust for schooling quality.

Uganda: Literacy by Years of Schooling Completed



Measuring Quality Differences in Schooling

- Given literacy rates by years of schooling: $\ell_i^n(s)$ and $\ell_i^a(s)$ for $s = 1, 2, ...$
- Assume that each year in rural school is worth γ years in urban school
- For each country i, solve for γ_i that solves

$$\min_{\gamma} \sum_{s=1}^{\bar{s}} \left(\tilde{\ell}_i^n(\gamma s) - \tilde{\ell}_i^a(s) \right)^2$$

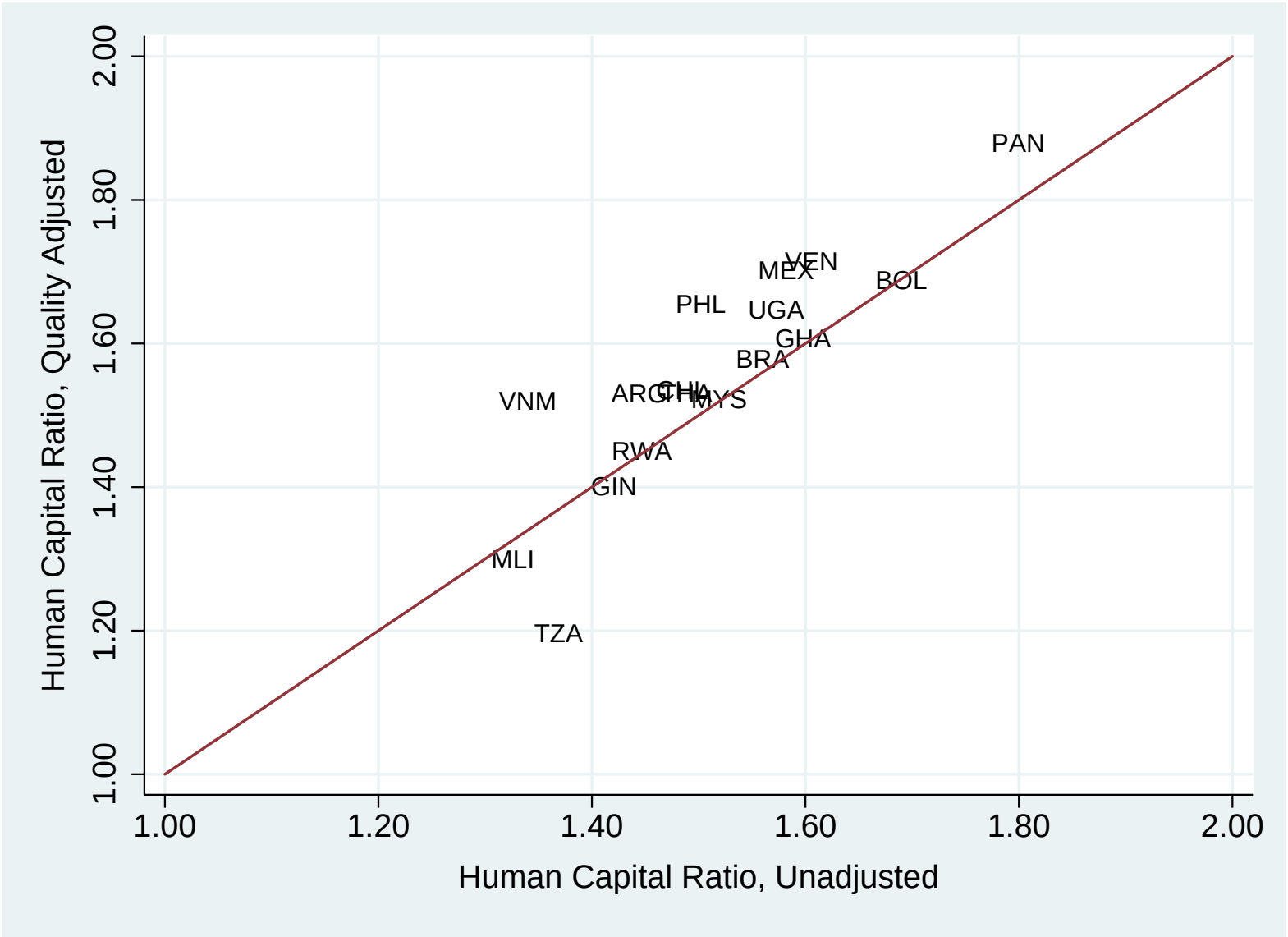
where $\tilde{\ell}_i^n(\cdot)$, $\tilde{\ell}_i^a(\cdot)$ are polynomial interpolations of $\ell_i^n(\cdot)$, $\ell_i^a(\cdot)$ for $s \in [0, \bar{s}]$.

Measuring Quality Differences in Schooling

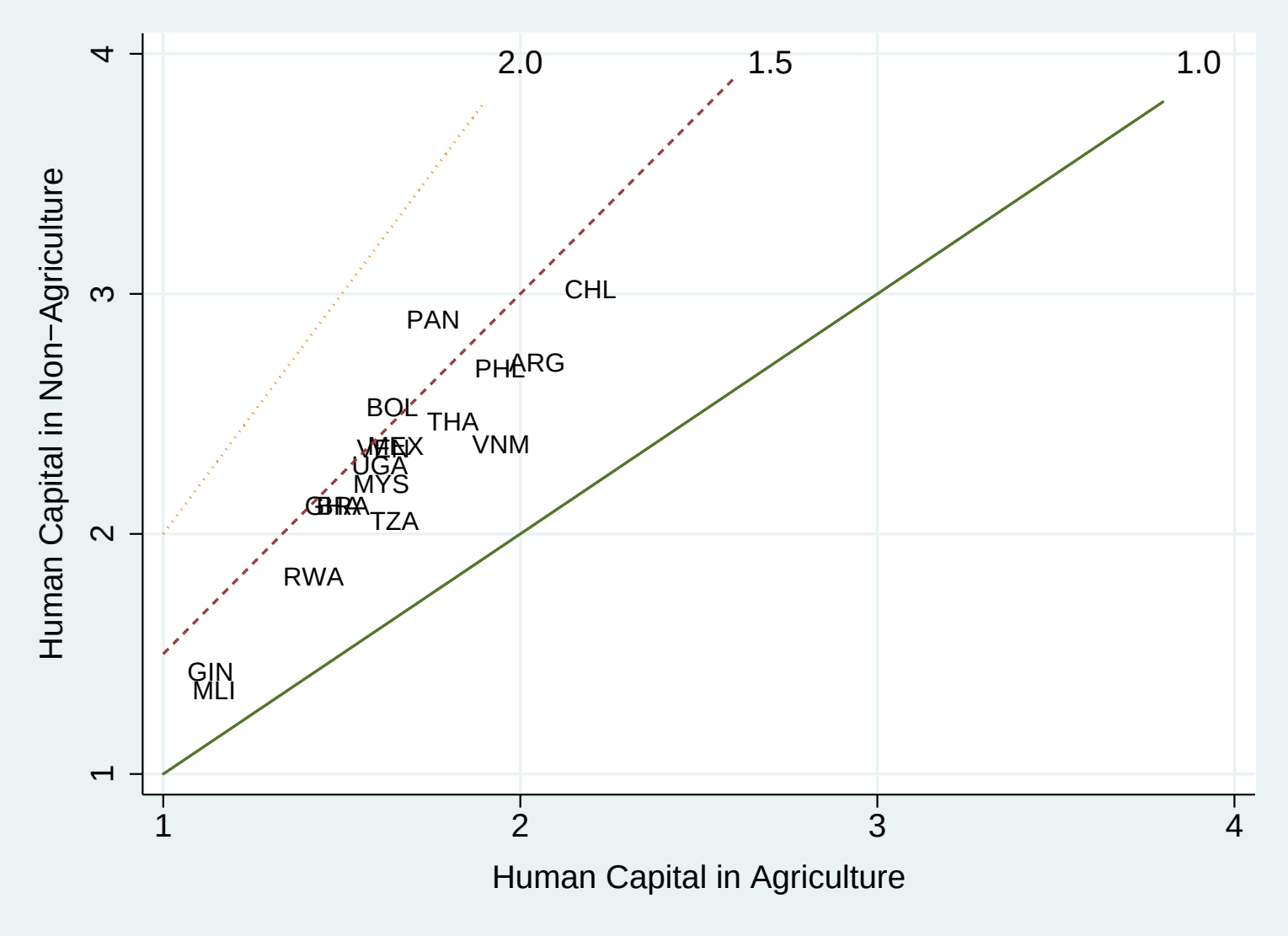
Table 3: Rural-Urban Education Quality Differences

Country	$\hat{\gamma}$
Argentina	0.87
Bolivia	0.95
Brazil	0.89
Chile	0.92
Ghana	0.90
Guinea	0.62
Malaysia	0.93
Mali	0.89
Mexico	0.77
Panama	0.87
Philippines	0.80
Rwanda	0.88
Tanzania	1.25
Thailand	0.90
Uganda	0.82
Venezuela	0.78
Vietnam	0.74
Average	0.87

Quality-Adjusted and Unadjusted Human Capital



Sectoral Differences in Quality-Adjusted Human Capital



Adjusting the Raw APG numbers

Recap:

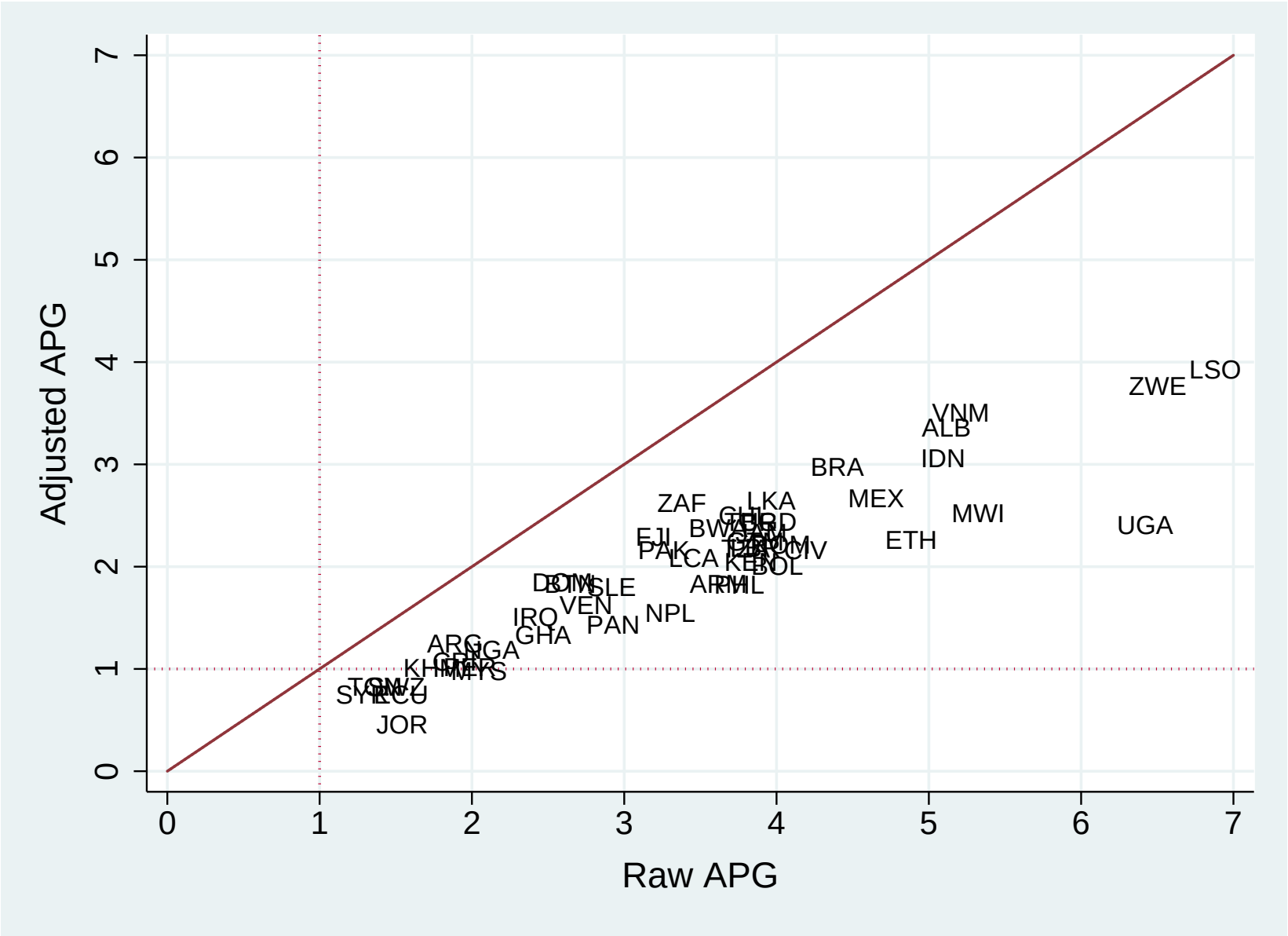
- Differences in hours worked contribute a factor of 1.2.
- Differences in human capital contribute a factor of 1.4.

Now, put them all together and construct "adjusted" APGs.

Adjusted Agricultural Productivity Gaps

Measure	Complete Data	All Countries
5th Percentile	0.8	0.7
Median	2.2	1.9
Mean	2.1	2.1
95th Percentile	3.9	3.9
Number of Countries	50	113

Raw vs Adjusted Gaps



Comparing Macro and Micro Data on Sector Value Added

The idea:

- Cross check "macro" value added data (from national accounts) with "micro" data from household income/expenditure surveys.

The data:

- Use World Bank's Living Standards Measurement Surveys (LSMS)
- Explicit goal of LSMS: household income and expenditure measures

Measuring Value Added from Micro Data

Agriculture:

$$
\begin{aligned}
VA_a &= \sum_i y_{a,i}^{SE} + \sum_i y_{a,i}^{L} + \sum_i y_{a,i}^{K}, \\
y_{a,i}^{SE} &= \sum_{j=1}^{J} p_j \left(x_{i,j}^{home} + x_{i,j}^{market} + x_{i,j}^{invest} \right) - COSTS_{a,i},
\end{aligned}
$$

Non-agriculture:

$$
\begin{aligned}
VA_n &= \sum_i y_{n,i}^{SE} + \sum_i y_{n,i}^{L} + \sum_i y_{n,i}^{K}, \\
y_{n,i}^{SE} &= REV_{n,i} - COSTS_{n,i}.
\end{aligned}
$$

$$
i = \text{household} \quad \text{and} \quad j = \text{agriculture commodity}.
$$

Comparison of Macro and Micro APG

	Agriculture Share of				
	Employment		Value Added	APG	
Country	Micro	Macro	Micro	Macro	Micro
Armenia (1996)	34.2	36.8	32.8	0.9	1.1
Bulgaria (2003)	14.1	11.7	18.4	1.2	0.7
Cote d'Ivoire (1988)	74.3	32.0	42.1	4.7	4.0
Guatemala (2000)	40.2	15.1	18.7	3.8	2.9
Ghana (1998)	53.9	36.0	33.3	2.2	2.3
Kyrgyz Republic (1998)	56.9	39.5	39.3	2.0	2.0
Pakistan (2001)	46.9	25.8	22.6	2.5	3.0
Panama (2003)	27.0	7.8	11.8	4.4	2.7
South Africa (1993)	11.0	5.0	7.0	2.3	1.7

Income and Expenditure Per Worker and APGs

Country	APG Micro	Income per Worker Ratio	Expenditure per Worker Ratio
Armenia (1996)	1.1	0.7	0.9
Bulgaria (2003)	0.7	1.4	1.2
Cote d'Ivoire (1988)	4.0	3.5	3.2
Guatemala (2000)	2.9	3.2	2.4
Ghana (1998)	2.3	2.0	1.9
Kyrgyz Republic (1998)	2.0	1.3	1.8
Pakistan (2001)	3.0	3.2	1.4
Panama (2003)	2.7	2.8	2.1
South Africa (1993)	1.7	1.7	1.2
Tajikistan (2009)	1.6	1.2	1.1

Different Labor Shares Across Sectors?

Production functions with different labor shares

$$Y_a = A_a L_a^{\theta_a} K_a^{1-\theta_a} \quad \text{and} \quad Y_n = A_n L_n^{\theta_n} K_n^{1-\theta_n}$$

In equilibrium

$$APG = \frac{Y_n/L_n}{p_a Y_a/L_a} = \frac{\theta_a}{\theta_n}$$

Macro evidence on θ_a, θ_n

- Employment share of agriculture varies a lot across countries;
- Aggregate labor share of GDP doesn't, Gollin (2002) $\Rightarrow \theta_a \approx \theta_n$

Micro evidence on θ_a, θ_n

- Sharecropping arrangements suggest $\theta_a \approx 0.5$
- Econometric estimates: $\theta_a \approx 0.5 - 0.6$

Cost-of-Living Differences

Purchasing power of nominal wages could differ in urban and rural areas

- APG>1 could reflect lower cost of living in rural (agricultural) areas

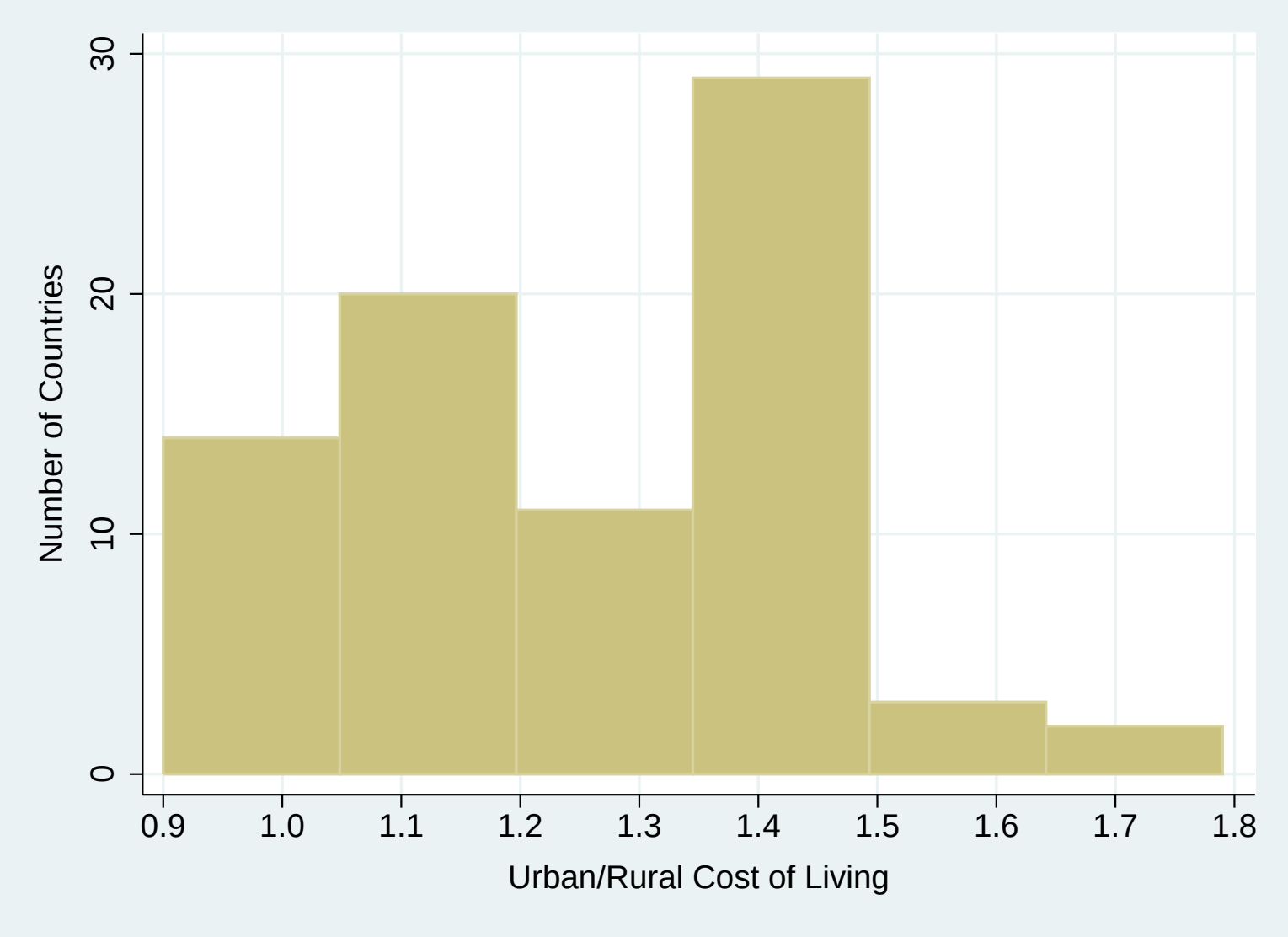
Chen, Ravaliion and Sangraula (2009): urban-rural COL differentials

- Estimates of urban-rural COL for household earning \$1 per day

Average country: urban-rural cost of living differential of 1.3.

- Not ideal for various reasons,
- But suggestive that this is not sufficient to close the gap.

Cost-of-Living Differences



Conclusion

- Typical developing country has large agricultural productivity gap
- Better measurement reduces gap from around 4 to around 2
- Large gaps also present in household survey data
- Needed: better understanding of why residual gaps so large

Why are Residual Gaps So Large?

- Yet more measurement error – Herrendorf and Schoellman (2011)
- Selection of more productive workers out of agriculture
  – Lagakos and Waugh (2012)
- Risk of migrating?
  – Harris and Todaro (1971), Bryan, Mubarak, Chowdhury (2011), others
- Other disutility of urban areas (social alienation? crime? pollution? decline in relative social status?)
  – Dercon et al (2012)

Individual Hours Worked By Sector

Hours Worked: A Further Breakdown

Country	Worker Classification	Sector of Hours Worked: Agriculture	Sector of Hours Worked: Non-agriculture
Cote d'Ivoire (1988)	Agriculture	35.1	1.0
	Non-agriculture	0.7	49.2
Ghana (1998)	Agriculture	28.8	3.7
	Non-agriculture	2.0	30.6
Guatemala (2000)	Agriculture	47.6	1.3
	Non-agriculture	0.8	49.1
Malawi (2005)	Agriculture	26.4	1.4
	Non-agriculture	2.3	38.2
Tajikistan (2009)	Agriculture	39.5	0.1
	Non-agriculture	0.1	39.3

Note: Workers are classified by sector according to their primary sector of

Agriculture Sector in Developing Countries