# Comments on "Capital Obsolescence and Agricultural Productivity"

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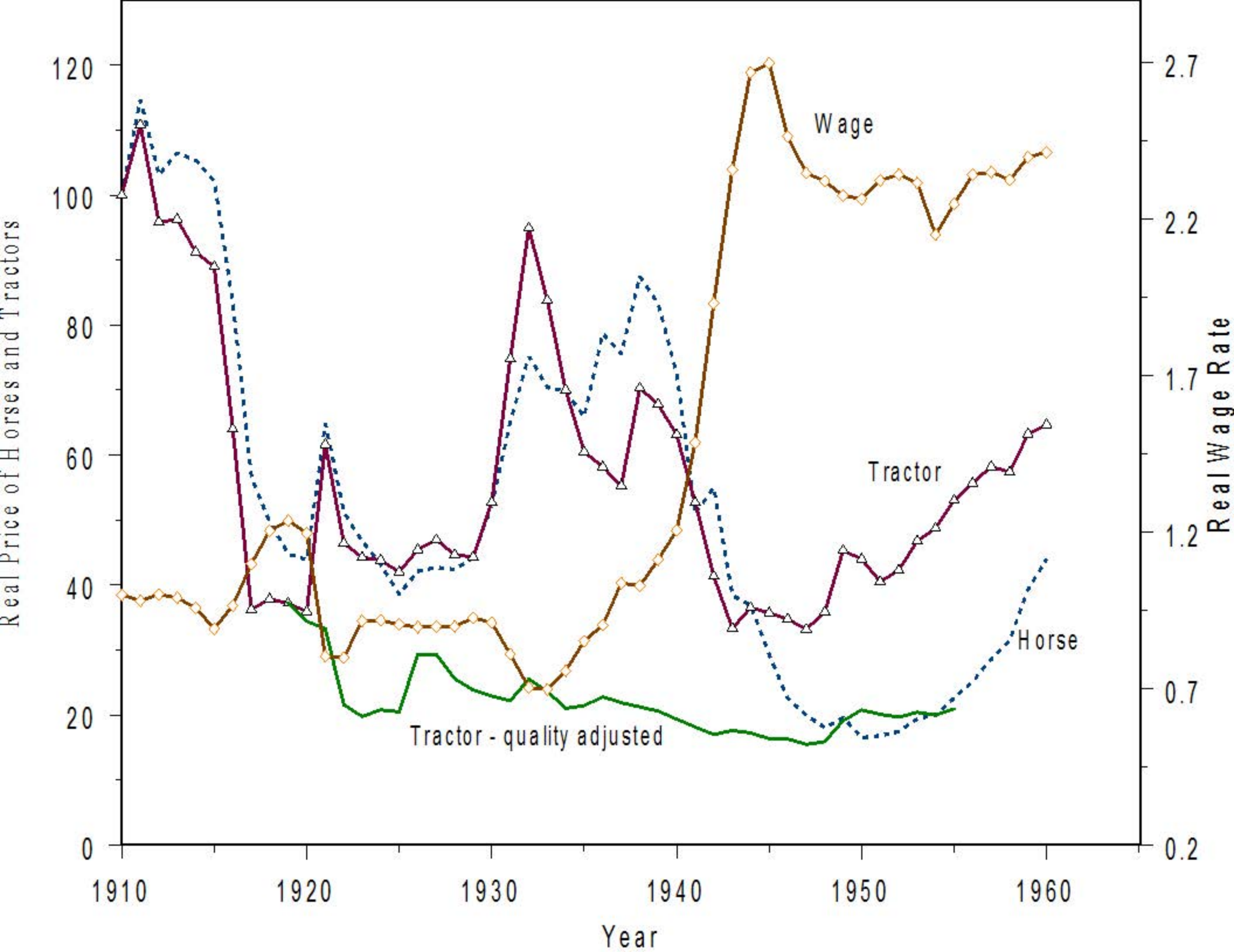
# Agricultural TFP and Embodiment

- Cross-country differences in Agricultural TFP are large
  - Several advanced countries grew by dramatically increasing agricultural TFP (relative to manufacturing TFP)
- An important theme in modern research - technological change is embodied on capital
- Widely believed that national income accounts do not fully capture improvements in quality

# Agricultural TFP and Embodiment

- One well-known approach is to examine the link between measured TFP and the age distribution of capital
- If the embodiment hypothesis were true, standard growth accounting exercises will underestimate the effect of recent investments (vintages) on current productivity relative to older investment.
- Approximate relationship owes to Richard Nelson (1964): embodiment implies that measured TFP growth negatively correlated with average age of capital stock
- Embodiment played an important role in the post-1973 productivity slowdown - Ed Wolff (1991)


Real Price of Horses and Tractors
Real Wage Rate
Year
Wage
Tractor
Horse
Tractor - quality adjusted
120
100
80
60
40
20
0
2.7
2.2
1.7
1.2
0.7
0.2
1910
1920
1930
1940
1950
1960

# This paper

- Explores the role of agricultural capital quality in accounting for cross-country variation in agricultural TFP
- The key idea is to identify the average quality of agricultural capital $\overline{q}$ and its growth rate $\mu$ in a country from the cross-sectional relationship between the price of agricultural capital $P_i$ and its age $a_i$ : $\log P_i = \beta + \beta_a \times a_i + \varepsilon_i$
  - In a vintage capital model, it shows that $\beta$ is a function of $\overline{q}$, and $\beta_a$ is a function of $\mu$
  - First estimate the price equation to obtain estimates of $\beta$ and $\beta_a$
  - then solve for $\overline{q}$ and $\mu$

# This paper

- Using data on second hand tractors in 13 countries, estimates the price equation and obtains $\overline{q}$ and $\mu$ for each country
- finds that agricultural capital quality
  - tends to be higher and grow faster in countries with a higher agricultural productivity
  - explains about 1/3 (1/4) of the cross-country disparities in the level (growth) of agricultural productivity

# Contributions

- Theoretically, it constructs a model that
  - allows the quality of agricultural capital to grow at different speeds in different economies along the BGP
  - provides a way to identify the quality of agricultural capital and its growth rate from the cross-sectional relationship between the price of agricultural capital and their age
- Empirically, it
  - documents age-price profiles of tractors across countries
  - estimates the average quality and growth rate of agricultural capital for each country
  - evaluates the role of the quality of agricultural capital in agricultural productivity

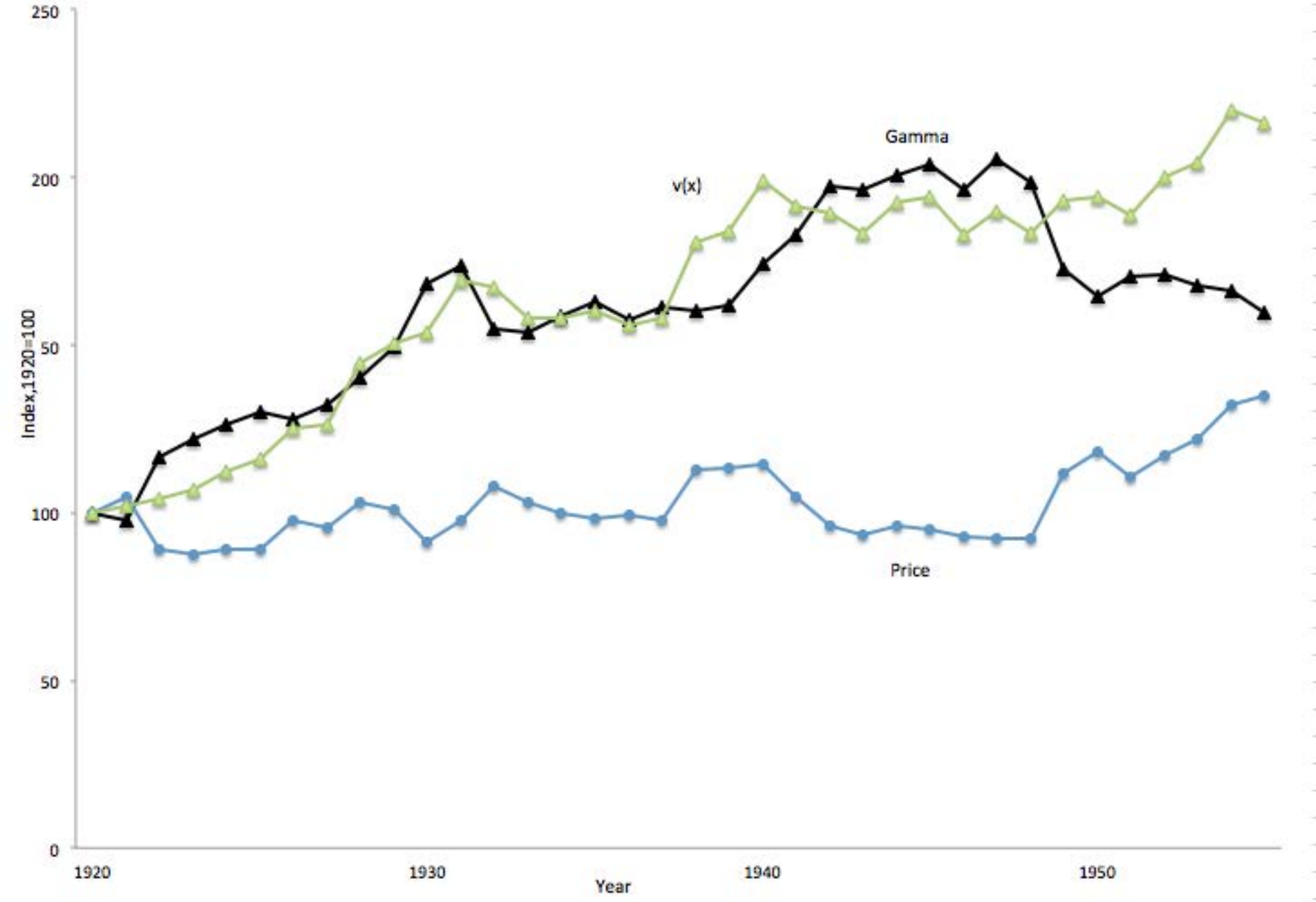
# Modeling Tractor Prices

$$p_{kt} = \frac{v(x_t)}{\gamma_{ct}}$$

$$q_{kt}(t) = p_{kt}(t)\left[1 - R_t(1)(1-\delta_{kt})\frac{\gamma_{ct}}{\gamma_{ct+1}}\right] + (1-\Delta_{t+1})C(t+1, T-1)$$

Forces at work in determining the rental price of a tractor:

- Price Effect: Increases in the price of a new tractor, $p_{kt}(t)$, increase the cost of operating it
- Anticipated productivity Effect: (low values of $\frac{\gamma_{ct}}{\gamma_{ct+1}}$) result in increases in the rental price of tractors
- Operating Cost Effect: The term $(1-\Delta_{t+1})C(t+1, T-1)$ captures the increase in cost *per unit of tractor services* associated with operating a one year old tractor, relative to a new tractor


250
200
50
100
50
0
Index,1920=100
Gamma
v(x)
Price
1920
1930
1940
1950
Year

# Main concerns

- Estimates of $\overline{q}$ and $\mu$ from the price equation could be contaminated for at least two reasons
  - The data may not be representative of all agricultural capital
  - Quality may not be the only determinants of price
- Other dimensions that capture quality

# Representativeness of the data

- There are at least two potential sources of selection
  - Tractors may not be representative of all agricultural capital
  - Tractors in the data may not be representative of all tractors in an economy
- In both cases, the age-price profiles may be different from the age-quality profiles of all agricultural capital: estimates of $\overline{q}$ and $\mu$ from the price equations are likely to be biased

# Tractors vs Agricultural capital

- Tractors may not be representative of all agricultural capital
  - Tractors, although important, are only part of agricultural capital in a country
  - For example, tractors only account for 1/3 of world trade in farm machinery
  - Not clear whether the age-price profiles of other agricultural capital follow the same pattern as tractors
  - Useful to check using data on other agricultural equipment
  - No need to do it for all countries, do it for whatever data available

# Tractors in the data vs all tractors

- The data only captures second hand tractors on the market
  - Due to informational problems, the sample of second hand tractors on the market may be very selective
  - The degree of selection may vary with tractor ages as the informational problem is likely to be worse for old tractors
  - The degree of selection may also vary across countries because the market for second hand tractors may not be equally well developed in all countries
- Issues may also arise from the small sample sizes
  - Number of observations is less than 100 for 7 out of the 13 countries (Table 1 in Online Appdendix)
  - Some but not much improvement after imputation
- Could be addressed by comparing the characteristics of the tractors in the data with those from other sources

# Price and quality

- The paper assumes a perfect market for agricultural capital so that all price differences are due to quality
- In reality, however, we know that the same good may be sold at different prices in different markets even after adjusting for exchange rates or purchasing power.
- Informational frictions mentioned previously is one explanation. Other explanations include the cross-country differences in market structures and distribution costs
- These frictions will invalidate both the mapping between $\beta$ and $\overline{q}$ and the mapping between $\beta_a$ and $\mu$, biasing the estimates of $\overline{q}$ and $\mu$ from the price equation $\log P_i = \beta + \beta_a \times a_i + \varepsilon_i$

# Price and quality: Suggestions

- One way to evaluate the importance of factors other than quality in determining prices is to
  - focus on a particular type of tractor used for a period of time in different countries
  - and compare the age-price profiles of this tractor across countries
  - There should be no significant cross-country differences in the age-price profiles if quality is the only determinant of prices
- Essentially, the suggestion is to complement the current analysis with some evidence from longitudinal data
  - Should be easy given the longitudinal relationship between $P$ and $a$ in the model
  - No need for all countries: do it for whichever country with such data

# Direct measures of quality

- Another approach is to look at measures of quality directly instead of prices
  - From example, use horsepower as a measure of quality and see whether the cross-country differences in age-horsepower profiles are similar to the age-price profiles
  - There are several other dimensions of tractor quality available from Nebraska Tractor Tests: Fuel Cost, Cylinders, Gears, RPM, HP, Plow Speed, Slippage, Length, Weight, Speed, Row Crop, Tires, Fuel

# Other suggestions: Depreciation

- The model in the paper implies $\beta_a = \ln \frac{1-\delta}{1+\mu}$ where $\delta$ is the annual rate of depreciation
- Given $\beta_a$ estimated from the price equation, $\mu$ can be identified as long as there is an estimate of $\delta$
- Potentially, $\delta$ could vary across countries because tractors are used with different intensities
- In estimating the country-specific $\delta$, however, the paper assumes that the average yearly hours of usage is the same across all countries
- Potentially because of this assumption, the estimated $\delta$ does not vary much across countries
- This attributes most of the variation in $\beta_a$ to $\mu$.
- The results may be different if the average yearly hours of usage is allowed to vary across countries.

# Other suggestions: Cross-State analysis

- The current analysis could be complemented with a cross-state analysis for the US.
- As countries differ from each other in many aspects not modeled in the paper, while the factors not captured in the model are more likely to be common across states,
- a similar finding from the cross-state exercise will make the results more convincing
- Such an exercise should be feasible given that majority of the data are from US

# Other suggestions: Other implications of the model

- The model in this paper has implications other than the age-price profiles
- For example, it has implications for the age structure of tractors in an economy
- Given the estimates of model parameters from age-price profiles for each country, the paper could test other model implications against data