Resource Reallocation and Industry-level Productivity Growth in Australian Broadacre Agriculture

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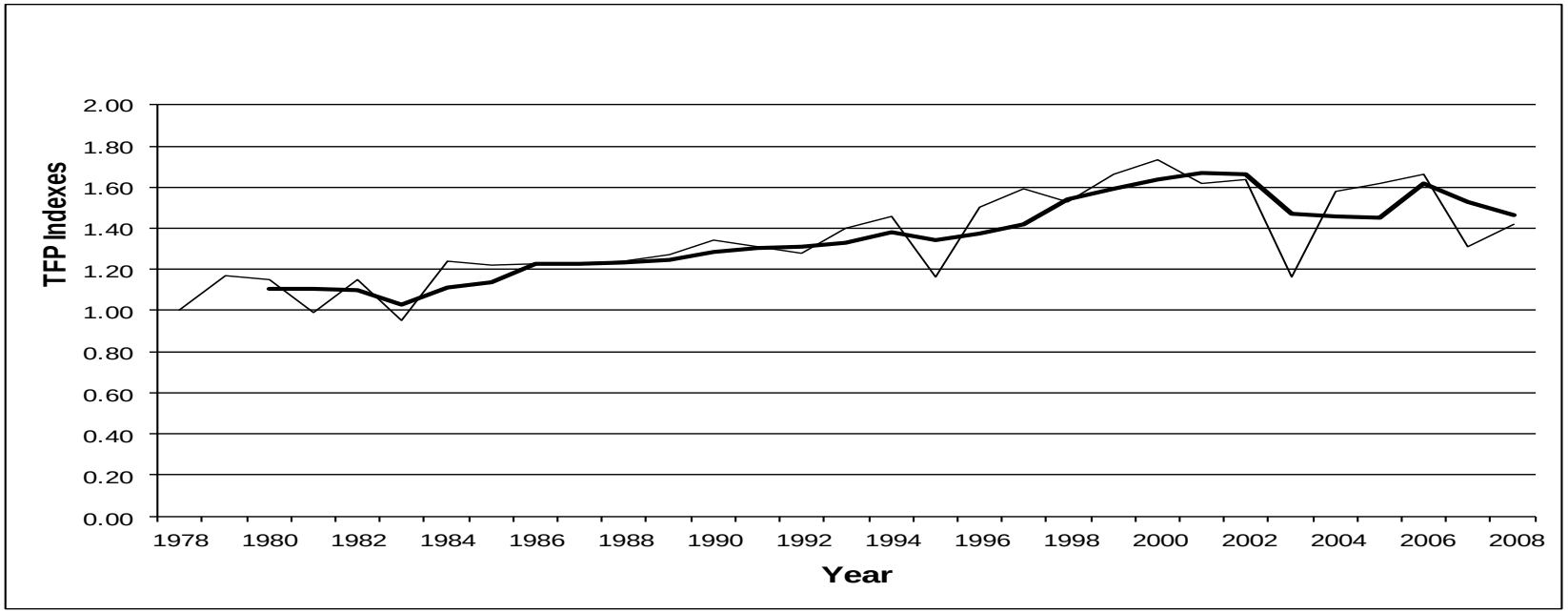
Background

- Industry-level productivity has grown in Australian broadacre agriculture.
  - 1.4 per cent a year at the industry level over the past four decades
  - Consistent across sub-sectors, though there are some differences

- Technological progress and structural adjustment are two important drivers.
  - Improved crop varieties, livestock breeds etc.
  - More efficient sowing and harvesting equipment
  - Fewer and larger farms

TFP in Australian Broadacre Industry: 1978-2008



	All industries	Cropping	Mixed	Sheep	Beef	Dairy
Input growth	-0.54	1.15	-1.44	-1.84	0.27	3.89
Output growth	0.84	3.08	-0.03	-1.45	1.79	4.7
TFP growth	1.38	1.93	1.41	0.38	1.52	0.82

Background

- Domestic policy settings played an important role
  - shaping farmers' incentives/capacities to adopt new technologies, and
  - removing impediments to structural adjustment which has facilitated the movement of resources across farms
- Policy discussions can be improved by understanding
  - the mechanisms through which policy settings influence industry-level productivity growth
- This paper uses farm-level productivity estimates to measure the influence of the reallocation of resources between farms on productivity growth.

Literature Review: Theory

- Industry-level agricultural productivity is
  - a weighted average of heterogeneous farm-level productivity
- Conceptually, it contains two components
  - Average growth in farm-level productivity, measuring the within-farm technology improvement/efficiency change
  - Shifting input usage/market share towards more efficient farms, measuring resource reallocation across farms
- Cross-farm resource reallocation is more sensitive to changes in policy settings, than within-farm technological progress.

Literature Review: Empirics

- Three strands of empirical literature measuring and analysing the resource allocation effects
  - Split into between-firm effects, cross-farm effects (for existing farms) and enter/exit effects (Baily et al. 1992, Tybout 1996, Foster et al. 2001)
  - Link the resource allocation effects to technological progress (Olley and Pakes 1996, Meltz and Polanec 2008, Hsieh and Klenow 2009)
  - Identify the relative mobility of different inputs in resource allocation (Petrin and Levinsohn 2005, Petrin et al. 2011)

- Limited focus on agriculture, to date
  - Inform cross-country comparison with farm survey data

Methodology: the BCH decomposition

Industry-level TFP Growth is written as

$$\Delta \Pi_t = \sum_i s_{it}\pi_{it} - \sum_i s_{it-1}\pi_{it-1}$$

The BCH approach decomposed it into five components

$$\Delta \Pi_t = \sum_{i\in C} s_{it-1}\Delta\pi_{it} + \sum_{i\in C}(\pi_{it-1} - \Pi_{t-1})\Delta s_{it} + \sum_{i\in C}\Delta\pi_{it}\Delta s_{it}$$
$$\sum_{i\in N} s_{it}(\pi_{it} - \Pi_{t-1}) - \sum_{i\in E} s_{it-1}(\pi_{it-1} - \Pi_{t-1})$$

(1) a within-farm effect: within-farm growth weighted by initial output shares

(2) a between-farm effect: changing output shares weighted by the deviation of initial farm TFP growth times plant share change

(3) a covariance term: a sum of farm TFP growth times farm share change

(4) an entry effect: a year-end share-weighted sum of the difference between TFP of entering plants and initial industry TFP

(5) an exit effect: an initial share-weighted sum of the difference between initial TFP of exiting plants and initial industry TFP.

Methodology: the OP decomposition

Industry-level TFP level is written as

$$\Pi_t = \sum_i s_{it}\pi_{it}$$

The OP approach decomposed it into two components

$$\Pi_t = \bar{\pi} + \sum_{i \in E}(s_{it} - \bar{s})(\pi_{it} - \bar{\pi})$$

(1) a within-farm effect: unweighted within-farm growth
(2) a between-farm effect: changing output shares weighted by the deviation of initial farm TFP growth times plant share change

Highlights the potential relationship between 'technological progress' and 'resource reallocation'.

Methodology: the PWR decomposition

Industry-level TFP level is written as

$$\prod_t \equiv \sum_i P_i dY_i - \sum_i \sum_k W_{ik} dX_{ik}$$

The PWR approach decomposed it by different types of inputs: intermediate vs. primary inputs

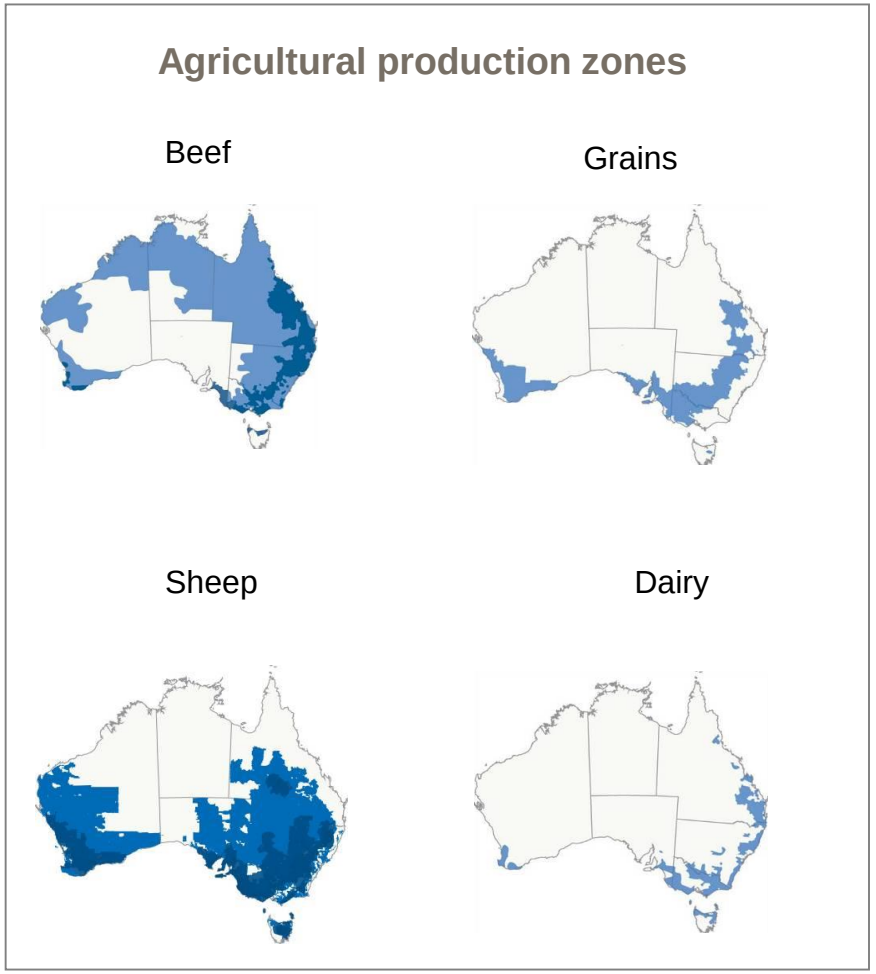
$$\prod_t = \sum_i \overline{D_{it}^v} \sum_k (\varepsilon_{ik} - \overline{s_{ik}}) \mathrm{dlnX_{ik}} + \sum_i D_i \sum_j (\varepsilon_{ij} - s_{ij}) dlnM_{ij} + \sum_i D_i dln\,\pi_i$$

Data Collection: Farm Surveys

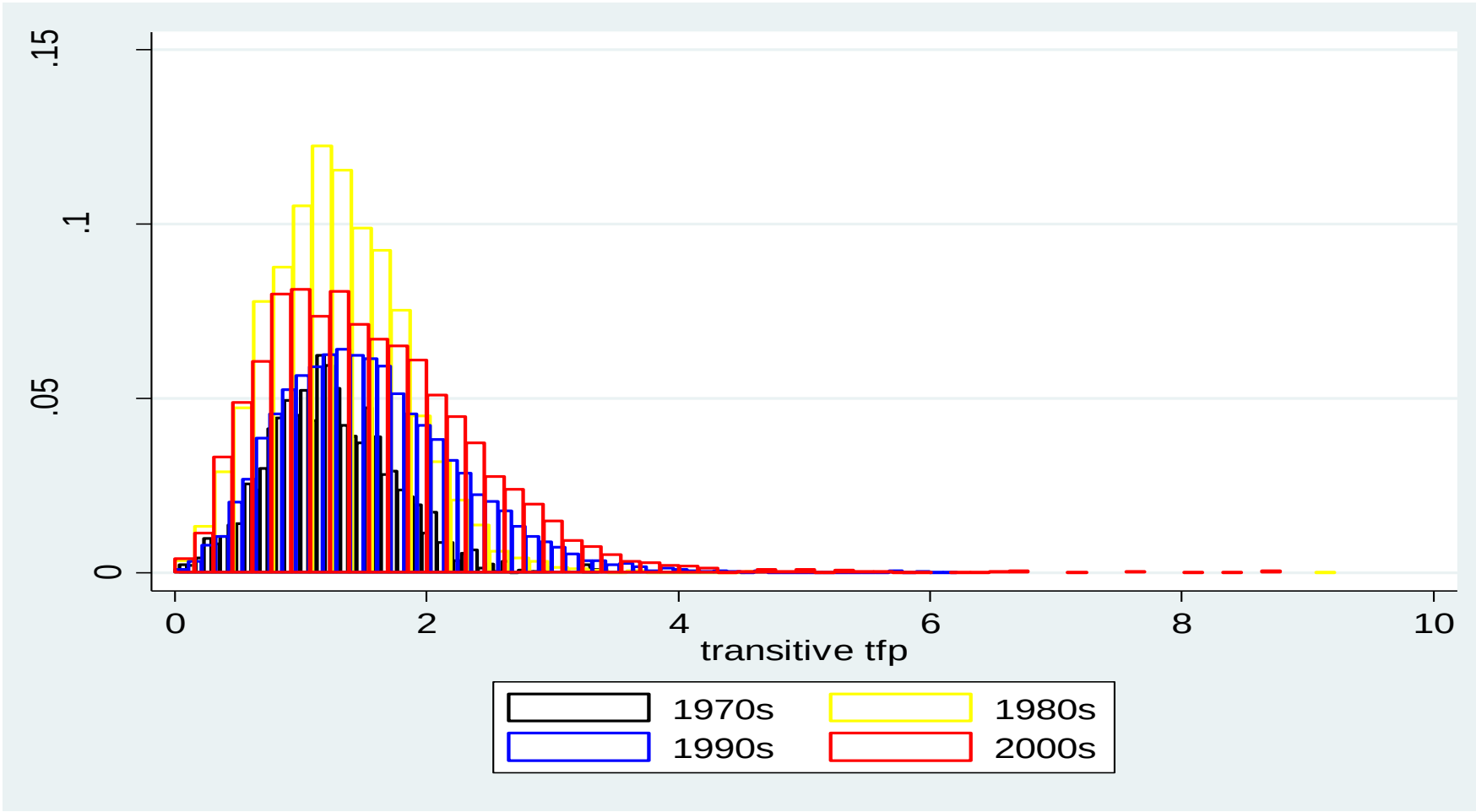
- Farm surveys are used (Australian Agricultural and Grazing Industry Surveys)
  - Time periods: 1978-2010
  - Non-irrigated farming: crop and livestock
- Random sampling strategy by strata with sample rotation
  - The sample weights need to be adjusted when applying the decomposition approaches
  - Need to be careful about the interpretation of the entry/exit effects
- Farm-level TFP estimated using the Fisher index, adjusted using the EKS formula.

Australian agriculture

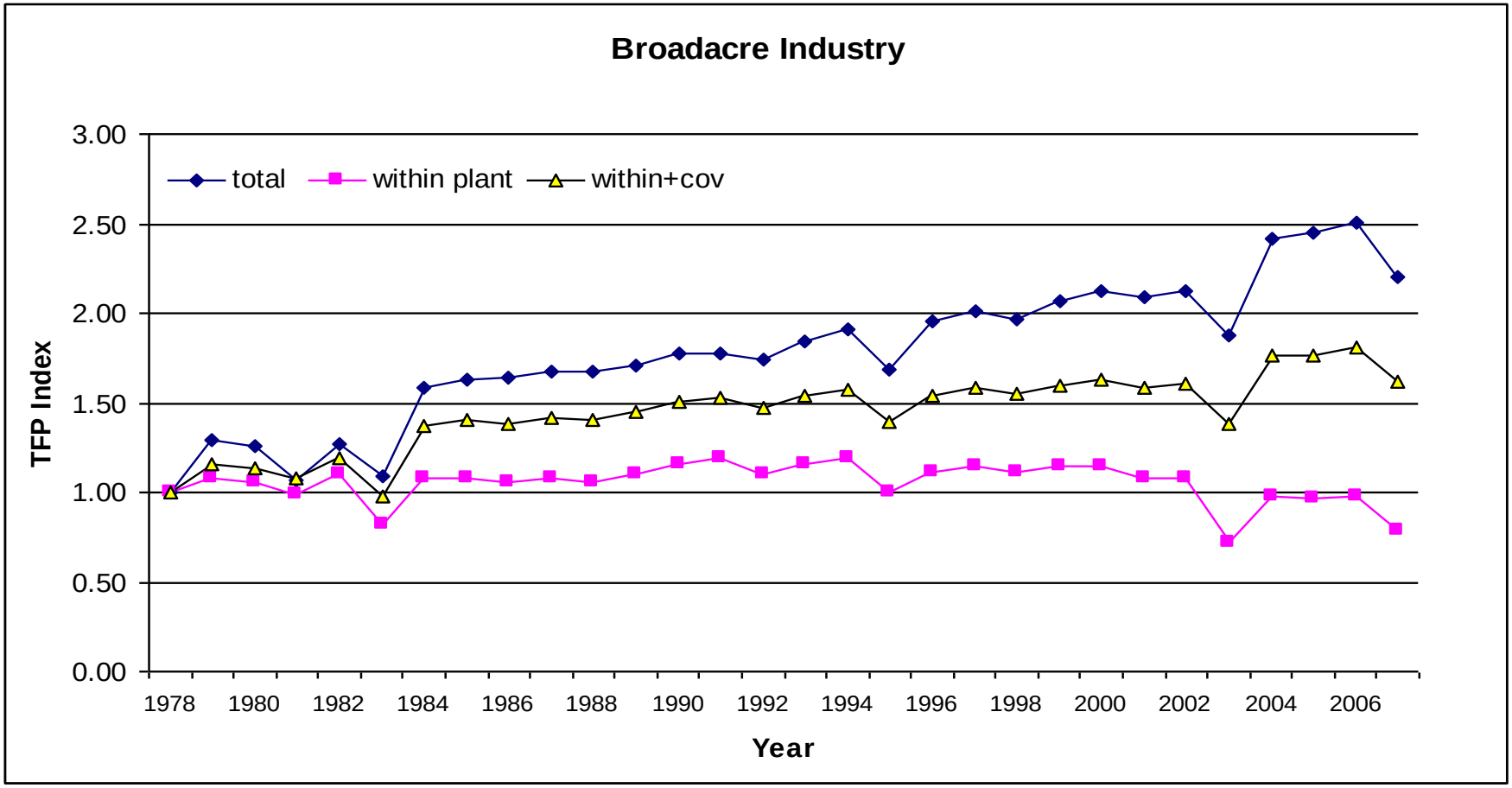
- A$52 billion produced in 2011-12
- 2.4% of Australian GDP and 2.5% of employment
- Broad national presence
- Two-thirds of production exported



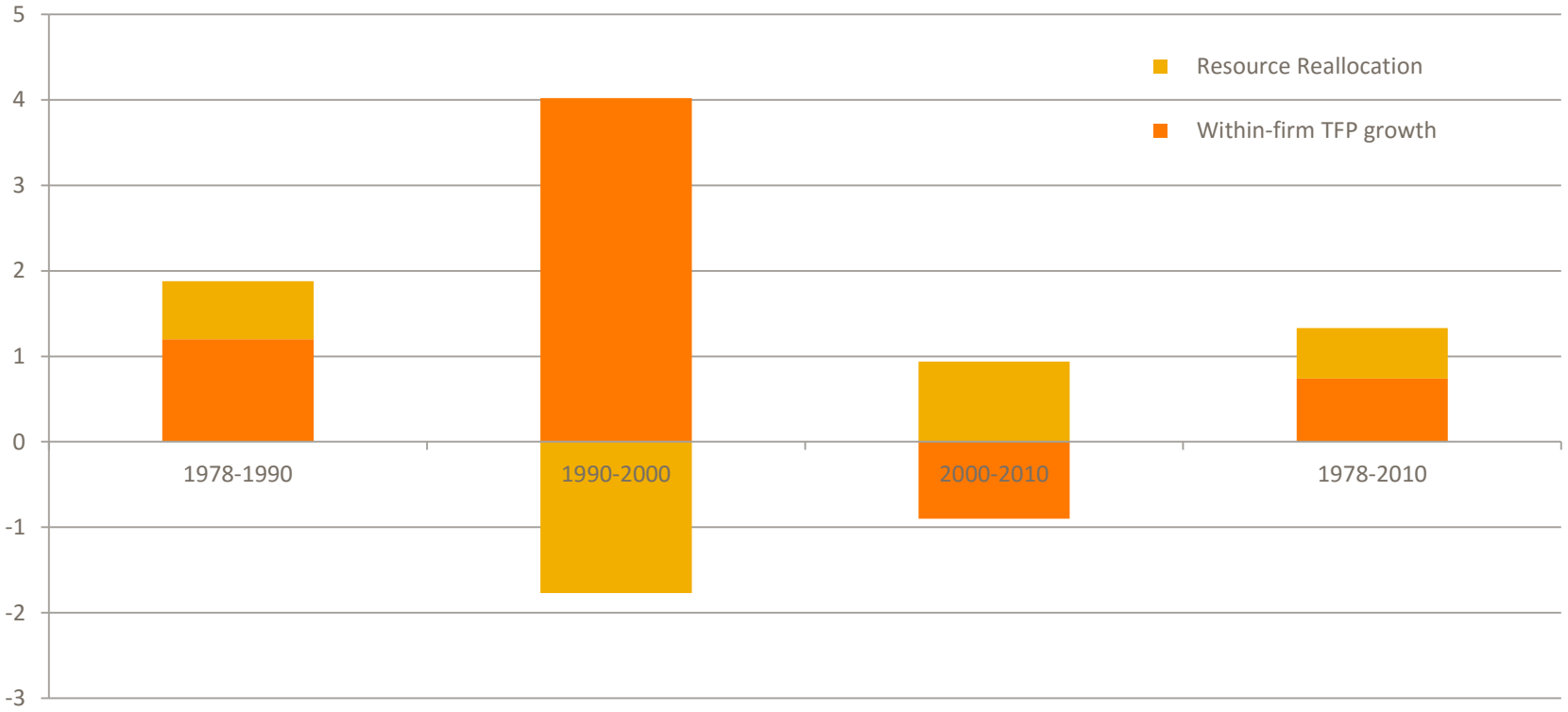
Changes in distribution of farm-level productivity: 1978-2008



Resource reallocation and its contribution to industry-level TFP Growth



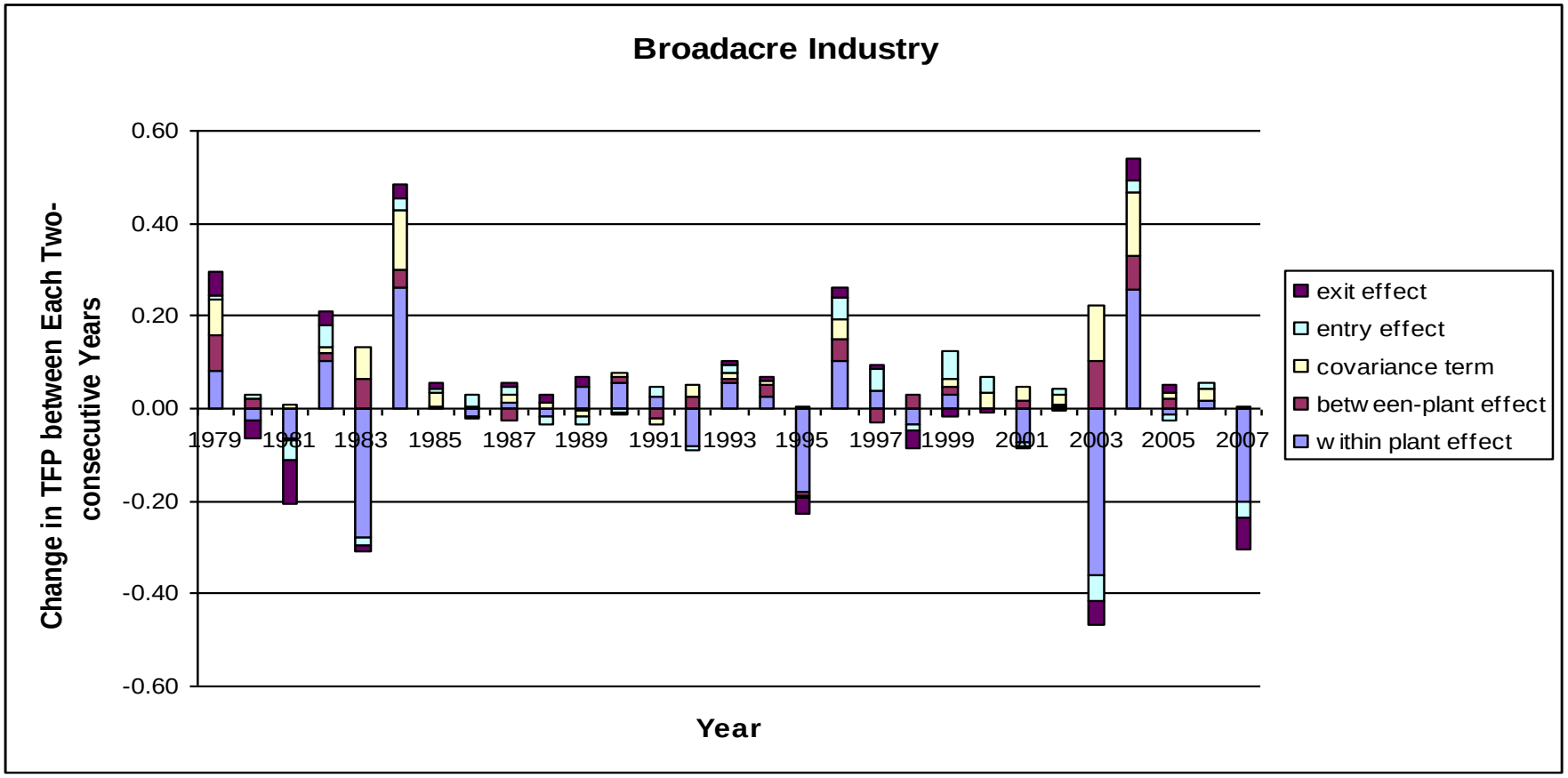
Resource reallocation and technological progress



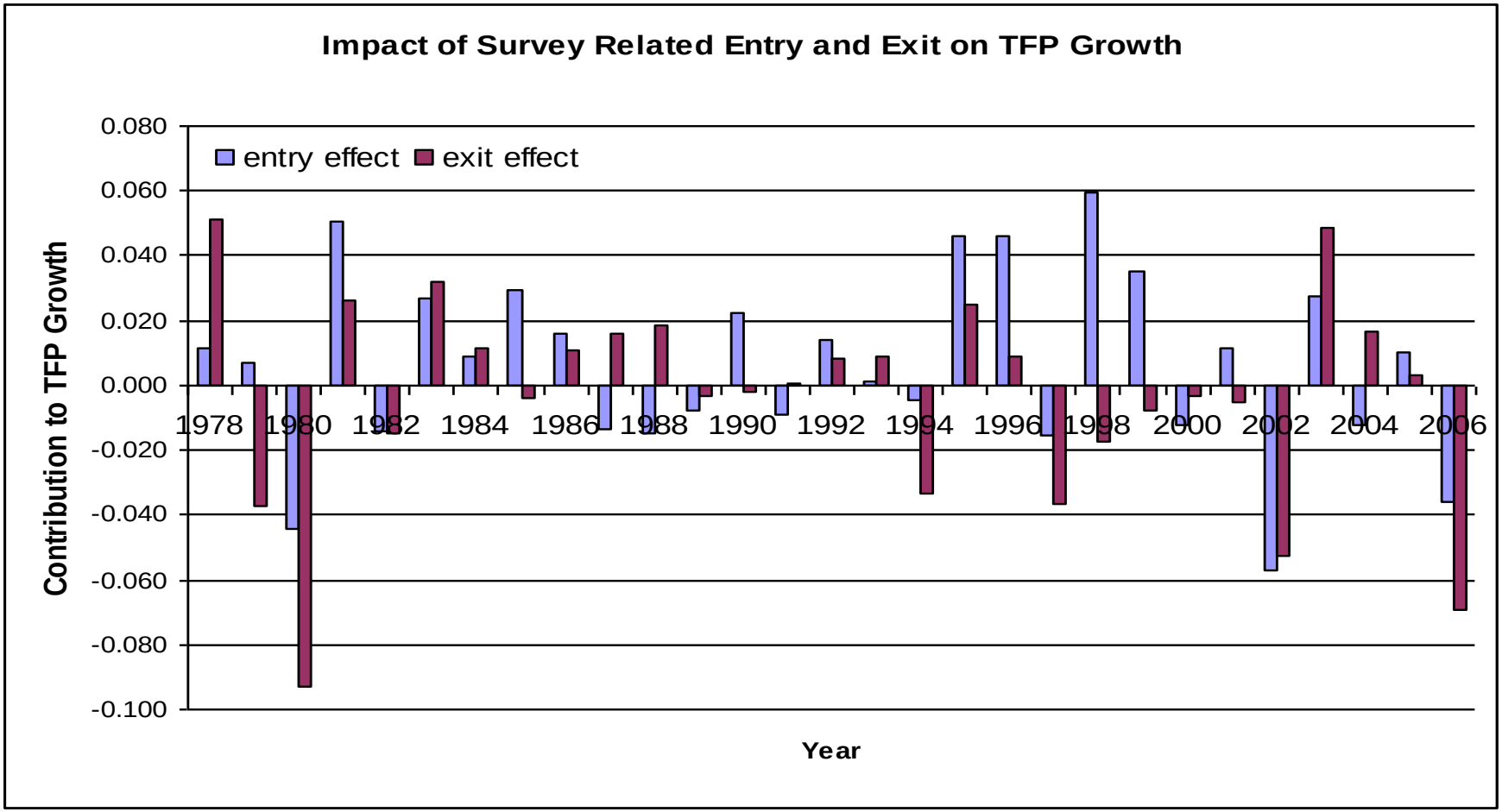
Farms' entry and exit from the sample: 1978-2010

		Share (%)		
year	Sample Size	Enter	Exit	Continue
1978	1,375	0.0	44.8	55.2
1979	917	15.3	62.2	22.5
1980	892	42.1	41.5	16.5
1981	923	55.6	33.1	11.3
1982	921	42.3	17.1	40.6
1983	924	18.6	28.9	52.5
1984	778	20.8	25.0	54.2
1985	770	27.3	20.3	52.3
1986	794	24.7	14.5	60.8
1987	1,047	37.6	19.1	43.3
1988	1,043	17.5	21.7	60.8
1989	1,114	19.1	22.7	58.2
1990	1,041	14.7	17.7	67.7
1991	1,654	41.2	19.6	39.2
1992	1,611	12.1	26.8	61.2
1993	1,525	15.6	24.0	60.4
1994	1,641	19.9	25.9	54.1
1995	1,435	18.8	36.7	44.6
1996	1,303	28.4	35.6	36.0
1997	1,387	33.9	42.8	23.3
1998	1,322	33.9	37.5	28.6
1999	1,224	31.8	41.5	26.7
2000	1,186	43.5	22.4	34.0
2001	1,221	23.2	28.0	48.8
2002	1,091	19.0	25.0	55.9
2003	1,342	32.8	24.6	42.5
2004	1,226	16.2	41.9	41.8
2005	1,508	40.3	28.0	31.8
2006	1,458	24.3	34.2	41.4
2007	1,482	38.5	43.9	17.6
2008	2,294	50.5	36.8	12.7
2009	1,638	23.0	27.1	49.9
2010	1,621	25.0	0.0	75.0

Does entry/exit matter

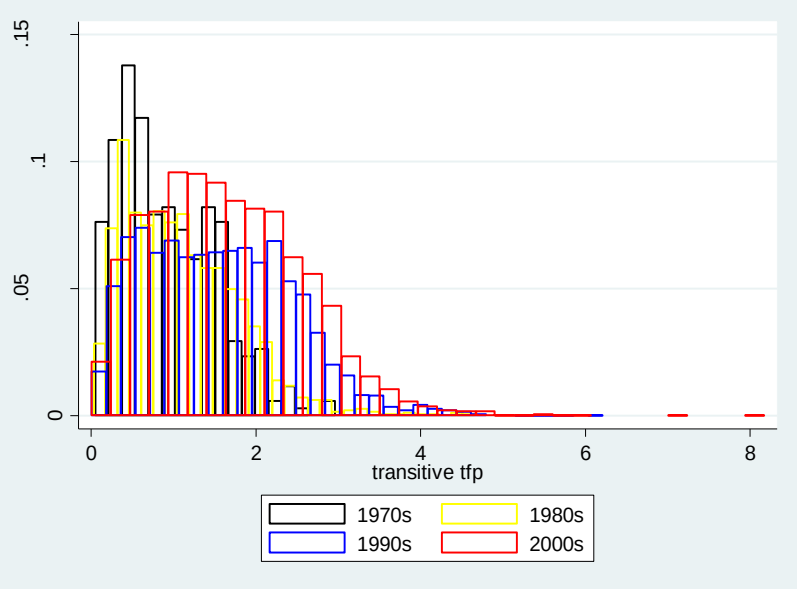


Does enter/exit matter

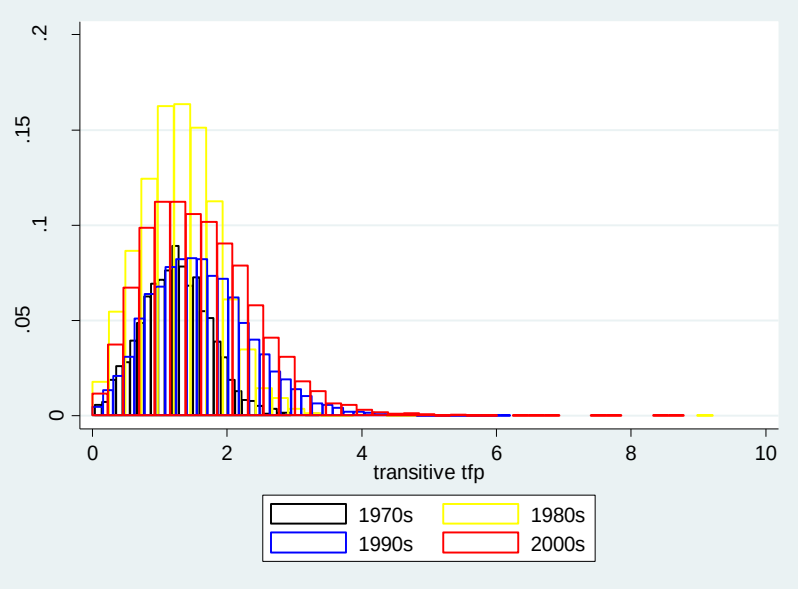


TFP distribution shifts: top 30% and bottom 70% of farms

Top 30%



Bottom 70%



Policy Implications

Removing impediments to resource reallocations across farms can boost industry-level agricultural productivity

- Foster research and development
- Minimise policy regulatory burden
- Pursue broader reform agenda

Conclusions

- There are many puzzles related to aggregate TFP and its interpretation.
- When the assumption of homogeneous farms is relaxed, we obtain an additional source of TFP growth and fluctuation (Melitz et al. 2003).
- For Australian broadacre agriculture, market-share shift (and its related resource re-allocation) seems to be another source of TFP growth.

Thank you

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