Real Wage Growth in Papua New Guinea over Three Decades

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Introduction

- Major contribution to understanding of labor market and wages in Papua New Guinea (PNG)
  - First longitudinal study of wages
  - Previously literature: infrequent, short time-horizon surveys
    - McGavin (1991), Levantis (1997a, 1997b), McGavin (1999), McGavin and Jones (2015)
- Novel dataset: superannuation database: data from 1980 to 2018
  - Population of private sector formal workers: 250K
- Findings
  - Economy-wide conditional real wage growth has averaged about 4.5 percent over 1999-2018
  - conditional real wage growth in the agricultural sector has lagged the services, industry and mining sectors
  - Real wage growth has followed the bust-boom-bust cycle of the macroeconomy
  - Men experience higher conditional real wage growth during the boom, also suffer bigger falls during bust
  - Agricultural sector conditional real wage hardest hit during bust, also lags during boom
  - Women in all sectors have higher conditional real wage growth

Papua New Guinea context

- PNG is classified as a resource rich developing country
  - Low-middle income country (GDP/capital $4000), resource export/GDP over 60%
  - Highly susceptible to changes in commodity terms of trade
  - Resource sector share of GDP varies from 13% to 34% of GDP over 1999-2018
- Poor countries in the world
  - bottom 25 percent on a wide range of Human Development Index measures (155th in 2019)
  - population 8.78 million (2019)
  - 85 percent of the population of PNG located in rural areas, restricted to agricultural activities
  - remaining 15 percent of the population live in small number of large urban centers.
- labor force 2.73 million in July 2020 (World Bank, 2020)
  - workers employed in the formal sector (both private and public sector) 366,000 (ANU, 2020).
  - number of formally-employed private sector workers was estimated at 257,000 (World Bank, 2019)
    - matches closely with the number of active contributors in the Nasfund database

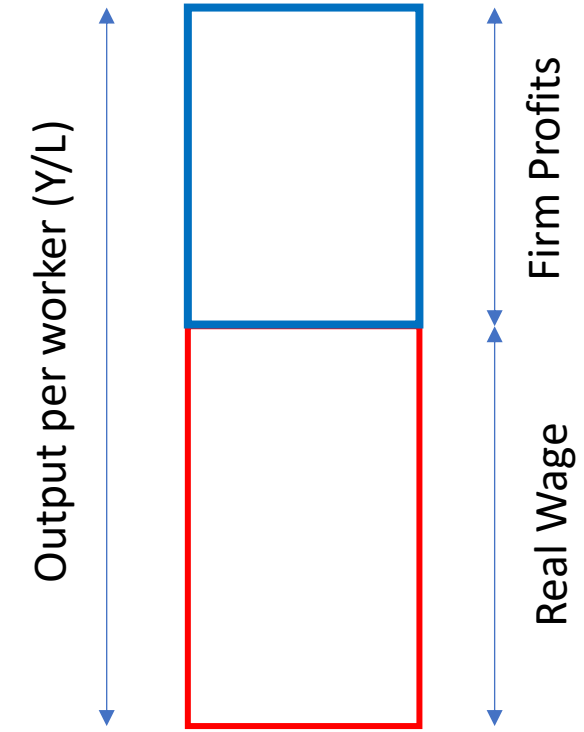
What is the real wage?

- Nominal wage (*W*): kina per hour (or per year)
- Price level (*P*): cost in kina of the basket of goods in that household consumes

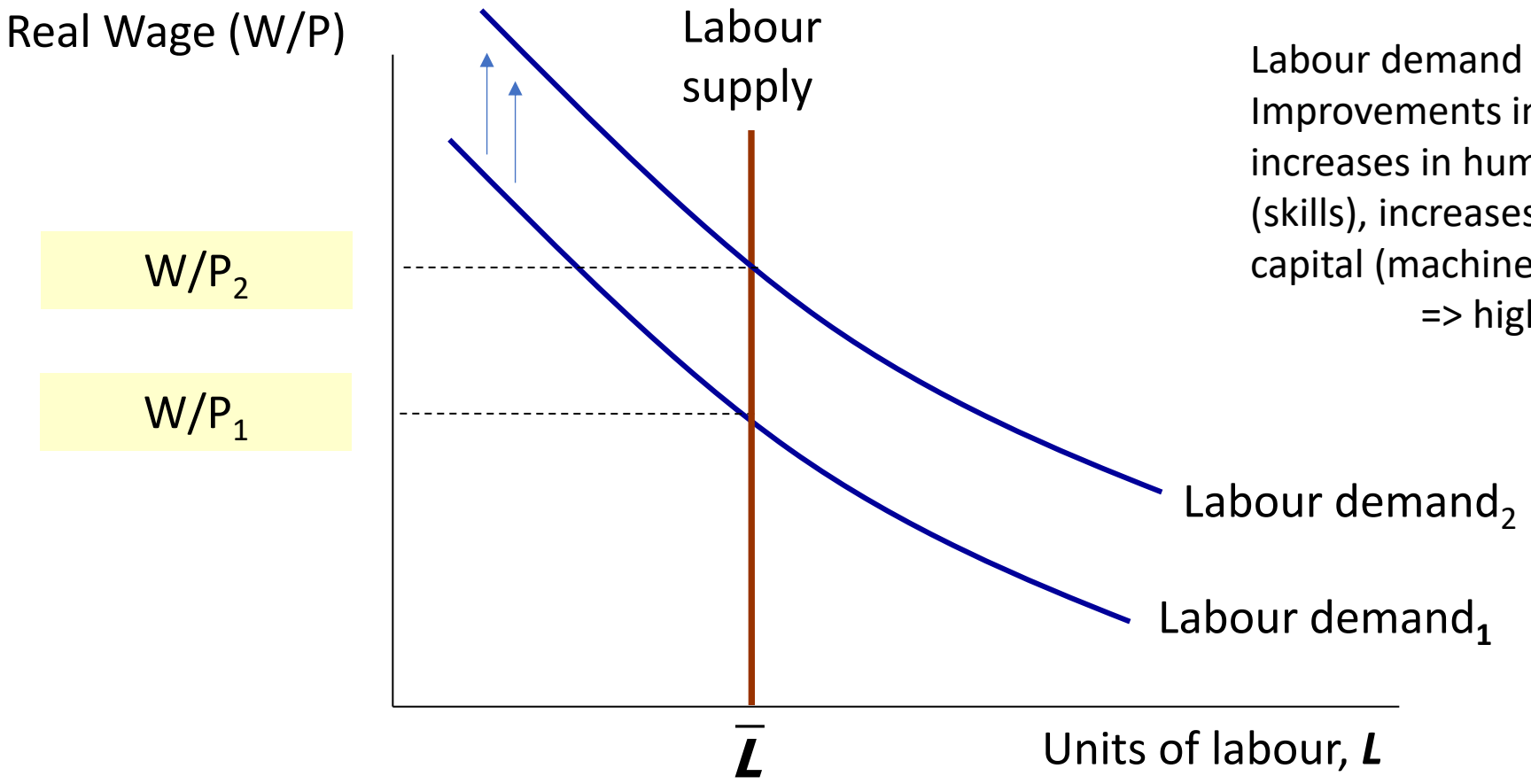
- Real wage: $\frac{W}{P}$ (number of baskets of goods per hour)

e.g. *W=20, P=2, W/P = 10 baskets*

- Determinants of *W/P*
  - worker skills, education, experience and ability
  - firm productivity, firm mark-up
  - wage bargain between workers and firms
    - minimum wage, taxes



What influences the real wage



Labour demand shifts up with Improvements in technology, increases in human capital (skills), increases in physical capital (machines, factories)

=> higher real wage

Why should we care about the real wage?

- Real wages (and real wage growth) matter!
  - key determinant of household well-being (evolution of well-being over time)

- Policy-makers
  - Evolution of real wages – and real wage growth – over time:
    - sectoral differences
    - gender differences
    - macroeconomic cycle
  - Asymmetric responses?

- Policy response: sectors or gender getting left behind?
- Intervention for:
  - sectors, a particular gender, or for particular sectors or gender during parts of cycle

What is this paper about? Contribution

- examine real wage growth for formal private sector in PNG over a 20-year period using a panel regression
  - span 3 decades: 1999 - 2018.
- Dataset: **population** (to close approx) of formally employed private sector workers

Contribution

- understanding of wages in (and the supply side of) PNG economy.
- thus far, paucity of wage information on PNG
  - to date, small and infrequent surveys
    - Literature: McGavin (1991), Levantis (2000), McGavin and Jones (2015)
    - Other: private sector surveys (quality?)
- first **longitudinal study** of wages in Papua New Guinea

Research questions

- Movement of ***conditional real wage growth*** in PNG over past two decades
  - full period and over macroeconomic cycle
  - conditional real wage growth = changes in the real wage controlling for individual worker fixed effects, experience etc

- Are there **sectoral** (agriculture, industry, mining, services) asymmetries in *conditional real wage growth*
  - Full period and macro cycle

- Are there **gender** asymmetries in *conditional real wage growth* in PNG
  - Full period and macro cycle

Data

- Nasfund superannunation database: largest private-sector superannuation fund in PNG
- Use four SQL tables
  - General ledger (history of all transactions)
  - Member (anonymous individual member employment history: continuing (active) or exiting (inactive)
  - Client (anonymous: individual member characteristics: age, sex, marital status, number of dependents)
  - Payroll (firm details and location)
- 670,000 unique individuals
- Utilize novel correspondence between the employer and employee compulsory contributions
  - Employer: 8.4% of gross salary; employee 6% of gross salary
  - annual wage panel for the period 1999-2018
  - Two alternative wage measures: one for each correspondence
- Merge with the available worker and firm information from all SQL tables
  - panel dataset of annual wages and individual and firm characteristics.

Dependent variable

- Individual annual real wages (deflated by CPI)
  - Nasfund is the largest private-sector superannuation fund in PNG
  - Includes bi-weekly savings for the past couple of decades
- Two alternative wage measures:
  - Worker savings contribution based
  - Employer savings contribution based
- annual wage panel for the period 1999-2018 merged with the available worker and firm information from other Nasfund databases
- panel dataset of annual wages and individual and firm characteristics.

Explanatory variables:

- Gender
- Age: age cohort dummies (16-24, 25-34,25-34,35-44,45-54,55-64)
- Experience: years in job
- Sector (Agriculture, Industry, Mining, Services, Other/NA)
- Herfindahl index – measure of industry concentration

- Omitted variables (education, training, other HK components, firm characteristics)

<u>Fixed effects</u>

- Control for non-time varying parts of omitted variables
- individual worker fixed effects:
  - controls for time-invariant part of education, training and other time-invariant omitted variables

Methodology

- **Conceptual Framework**
- Becker-Mincer-Chiswick Human Capital Theory framework

- **Empirical Strategy**
- Mincer equations for three alternative specifications:
  i. OLS
  ii. Panel models using individual worker fixed effects (focus of FE)
  iii. Panel models using individual worker random effects
- Used Hausman test to at least empirically offer some way of choosing between (ii.) & (iii.)

Table 1a. OLS, Fixed- and Random Effects Wage Regressions for PNG, 1999-2018: Full Sample Using Time Trend to Capture Productivity and Other Time Effects

	OLS		*Fixed Effects (FE)*		*Random Effects (RE*	
Wage measure	*Employee-based*	*Employer-based*	*Employee-based*	*Employer-based*	*Employee-based*	*Employer-based*
Female	0.055***	0.058***			-0.018***	-0.016***
	[0.005]	[0.005]			[0.004]	[0.004]
Age 25-34	0.428***	0.423***	0.426	0.522	0.371***	0.366***
	[0.013]	[0.013]	[0.399]	[0.482]	[0.011]	[0.011]
Age 35-44	0.826***	0.814***	0.596	0.697	0.719***	0.708***
	[0.013]	[0.013]	[0.394]	[0.477]	[0.011]	[0.011]
Age 45-54	1.087***	1.073***	0.381	0.504	0.900***	0.889***
	[0.014]	[0.014]	[0.391]	[0.474]	[0.012]	[0.012]
Age 55-64	0.793***	0.789***	0.457	0.562	0.488***	0.487***
	[0.014]	[0.014]	[0.389]	[0.473]	[0.012]	[0.011]
Mining	1.659***	1.625***			1.197***	1.179***
	[0.011]	[0.011]			[0.009]	[0.009]
Industry	0.459***	0.454***			0.328***	0.337***
	[0.008]	[0.008]			[0.007]	[0.007]
Services	0.713***	0.725***			0.393***	0.419***
	[0.008]	[0.008]			[0.006]	[0.006]
Other or NA	0.768***	0.764***			0.572***	0.573***
	[0.008]	[0.008]			[0.006]	[0.006]
Herfindahl Index	230.904***	339.661***	-232.182***	-124.333***	-692.458***	-529.853***
	[40.498]	[39.806]	[27.507]	[26.350]	[29.166]	[27.695]
Time trend	0.026***	0.027***	0.047***	0.045***	0.037***	0.037***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Constant	-45.768***	-46.662***	-86.693***	-82.801***	-67.970***	-66.655***
	[0.702]	[0.693]	[0.801]	[0.829]	[0.577]	[0.564]

Notes: N = 1,406,594 (person-year observations). All standard errors are clustered at the person level. The youngest cohort (persons between 16 and 24 years of age) is the reference age group, while Agriculture is the reference sector.

Results I

- Mining, Industry, and Services all pay higher wages than Agriculture (reference sector) (in that order). Wage premium, over agriculture, for
  - Mining: 120-165 percent
  - Industry: 33-46 percent
  - Services: 39-72 percent
  - average conditional real wage growth of between 2.6 and 4.7 percent per year, depending on the wage measure and model specification

Table 2. Trend Coefficient (Only) from Fixed-Effects Wage Regressions for PNG, 1999-2018: Stratified by Gender and Sector (Separately)

	By Gender:		*By Sector:*				
	Women	*Men*	*Agriculture*	*Mining*	*Industry*	*Services*	*Other/NA*
Employee-based wage measure							
Time trend	0.047***	0.047***	0.023***	0.059***	0.035***	0.034***	0.036***
	[0.001]	[0.000]	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]
Employer-based wage measure							
Time trend	0.045***	0.046***	0.022***	0.054***	0.032***	0.032***	0.035***
	[0.001]	[0.000]	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]
N	406,991	999,603	125,061	85,121	262,812	773,537	160,063

Notes: Similar to the results presented in Table 1, age cohort dummies and the Herfindahl index are included as additional control variables, as well.

Results II: sectors

- ordering of sectoral conditional real wage growth between mining, industry, and services fits
  - mining: 5.9%
    - boosted by new resource projects (including LNG investment boom, 2010-2013), investment in new technology and capital
  - Industry and services: ≈ 3.5%
    - at odds with Baumol cost disease (Baumol and Bowen, 1966) - services prody growth < industry prody growth
    - further, employment shares: services falling, industry rising, agriculture falling (next paper)
  - Agriculture: 2.3%
    - Lowest relative to other sectors
      - Need not be the poorer cousin
    - Underinvestment in supporting infrastructure: failure to stimulate investment of capital and new technology

Table 3. Trend Coefficient (Only) from Fixed-Effects Wage Regressions for PNG, 1999-2018: Stratified by Gender and Sector (Simultaneously)

	Agriculture		*Mining*		*Industry*		*Services*		*Other/NA*	
	Women	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*
Employee-based wage measure										
Time trend	0.034***	0.021***	0.057***	0.060***	0.041***	0.033***	0.036***	0.034***	0.041***	0.034***
	[0.003]	[0.001]	[0.004]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]
Employer-based wage measure										
Time trend	0.034***	0.020***	0.054***	0.054***	0.038***	0.030***	0.033***	0.031***	0.039***	0.033***
	[0.003]	[0.001]	[0.003]	[0.001]	[0.002]	[0.001]	[0.001]	[0.001]	[0.002]	[0.001]
N	24,471	100,590	11,239	73,882	58,337	204,475	268,601	504,936	44,343	115,720

Notes: Similar to the results presented in Table 1, age cohort dummies and the Herfindahl index are included as additional control variables, as well.
Source: Nasfund (1999-2018).

Results III: gender and sector

- women experience greater conditional real wage growth than men in all sectors except mining (no difference)
- Explanation
  - greater impediments to enter the workforce for women
  - Higher threshold to enter
    - Fewer women in the workforce
    - those who make it have higher average quality

Economic Conditions: 1999-2018

- Three sub-periods: bust-boom-bust :

- **1999-2002 (bust):**
  - Low commodities prices
  - Severe drought over 1995-1997
  - Low growth due to preceding years of poor governance, corruption and low commodities prices
- **2003-2013 (boom):**
  - large and sustained improvement in the commodity terms of trade leading to robust growth
  - punctuated by the global financial crisis in 2009 (large and offsetting fiscal stimulus)
  - concluded with an investment boom during 2010-2013 (construction of LNG gas project infrastructure)
- **2014-2018 (bust):**
  - End of commodities supercycle and investment boom
  - Low commodity prices and foreign exchange rationing by BPNG (central bank)
  - Recession / sluggish growth in non-resource sector
  - Mining sector boom, but no spillovers to rest of economy (enclave effect)

Table 4. Trend Coefficient (Only) from Fixed-Effects Wage Regressions for PNG, 1999-2018: Stratified by Pertinent Macro Economy Relevant Time Periods—Full Sample and by Gender

	Full sample:			*By gender:*					
				Women	*Men*	*Women*	*Men*	*Women*	*Men*
	1999-2002	2003-13	2014-18	1999-2002		2003-13		2014-18	
Employee-based wage measure									
Time trend	-0.086***	0.084***	-0.008***	-0.086***	-0.085***	0.075***	0.088***	0.001	-0.012***
	[0.002]	[0.001]	[0.001]	[0.004]	[0.002]	[0.001]	[0.001]	[0.002]	[0.001]
Employer-based wage measure									
Time trend	-0.076***	0.079***	-0.006***	-0.075***	-0.076***	0.070***	0.083***	0.003*	-0.009***
	[0.002]	[0.001]	[0.001]	[0.004]	[0.003]	[0.001]	[0.001]	[0.001]	[0.001]
N	156,548	756,919	493,127	43,291	113,257	214,617	542,302	149,083	344,044

Results IV

- Macro-cycle sub-periods
  - Bust 1999-2002: 7.6 - 8.6 % decrease
  - Boom 2003-2013: 7.9 - 8.4% increase
  - Bust: 2014-2018: 0.6 - 0.8% decrease

- Gender
  - men experience a larger increase in real wages during the boom
  - first bust: men and women hit equally
  - Second bust: men bear a higher burden of negative shock

Table 5. Trend Coefficient (Only) from Fixed-Effects Wage Regressions for PNG, 1999-2018: Stratified by Pertinent Macro Economy Relevant Time Periods—by Sector

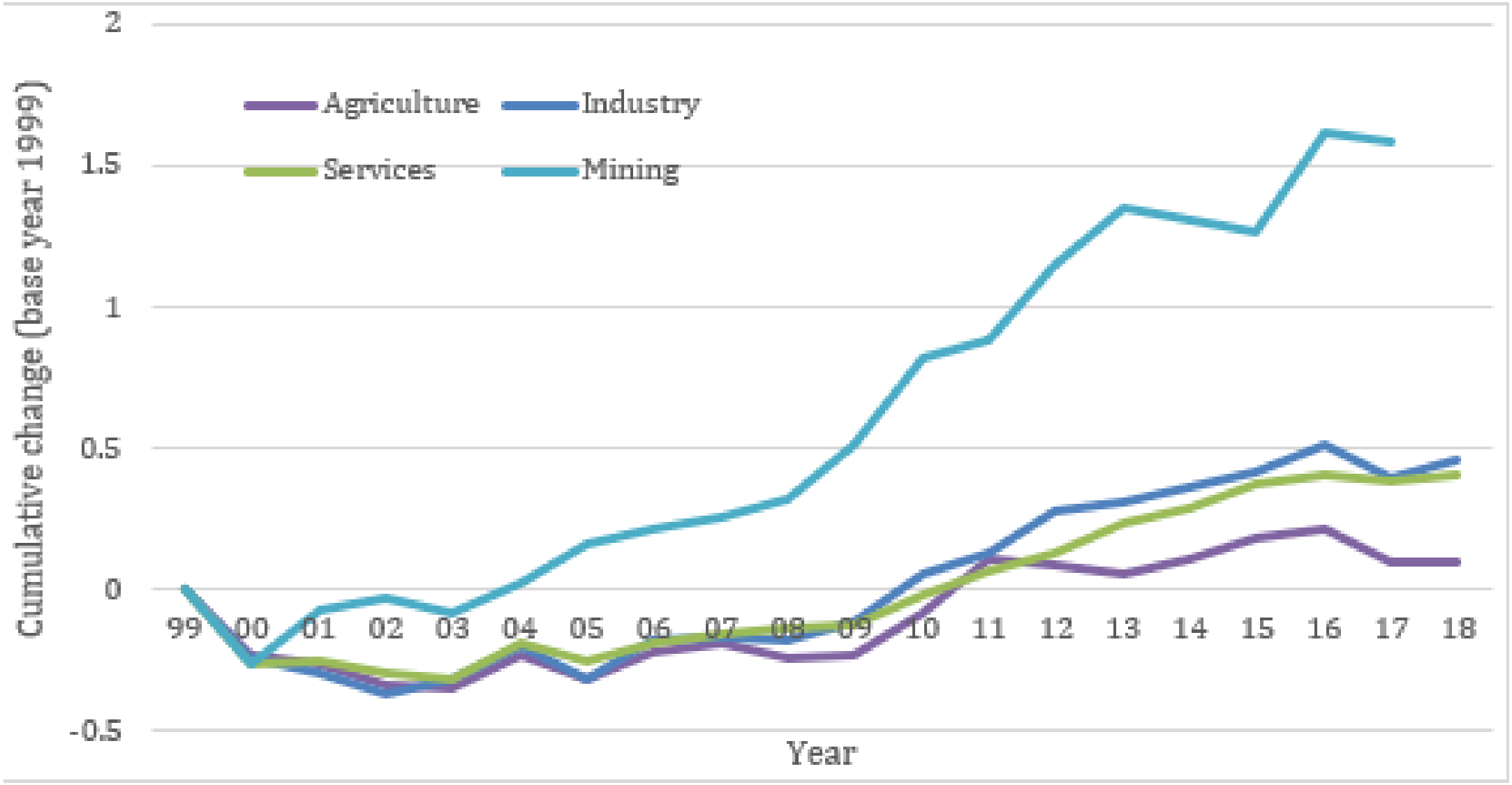
	Employee-based wage measure			*Employer-based wage measure*		
	1999-2002	2003-13	2014-18	1999-2002	2003-13	2014-18
Agriculture	-0.227***	0.109***	-0.017**	-0.213***	0.108***	-0.020***
	[0.017]	[0.003]	[0.007]	[0.016]	[0.003]	[0.007]
Mining	-0.264***	0.172***	0.009***	-1.142***	0.177***	0.013***
	[0.027]	[0.006]	[0.003]	[0.066]	[0.005]	[0.003]
Industry	-0.045***	0.160***	-0.050***	-0.055***	0.151***	-0.059***
	[0.006]	[0.004]	[0.005]	[0.006]	[0.003]	[0.005]
Services	0.049***	0.109***	-0.012***	0.045***	0.013***	-0.016***
	[0.007]	[0.002]	[0.002]	[0.007]	[0.003]	[0.002]
Other/NA	-0.030**	0.112***	-0.010***	-0.062***	0.098***	-0.006*
	[0.012]	[0.005]	[0.003]	[0.013]	[0.005]	[0.003]

Notes: Similar to the results presented in Table 1, age cohort dummies and the Herfindahl index are included as additional control variables, as well.
Source: Nasfund (1999-2018).

Results IV

- Sector: conditional real wage
  - Agriculture hit harder during busts and lags other sectors during booms
  - mining sector decline during the first bust, grew subsequently
  - Services and industry, in the middle, follow the cycle
    - Mining recovers faster than both Industry and Services during the boom and following bust

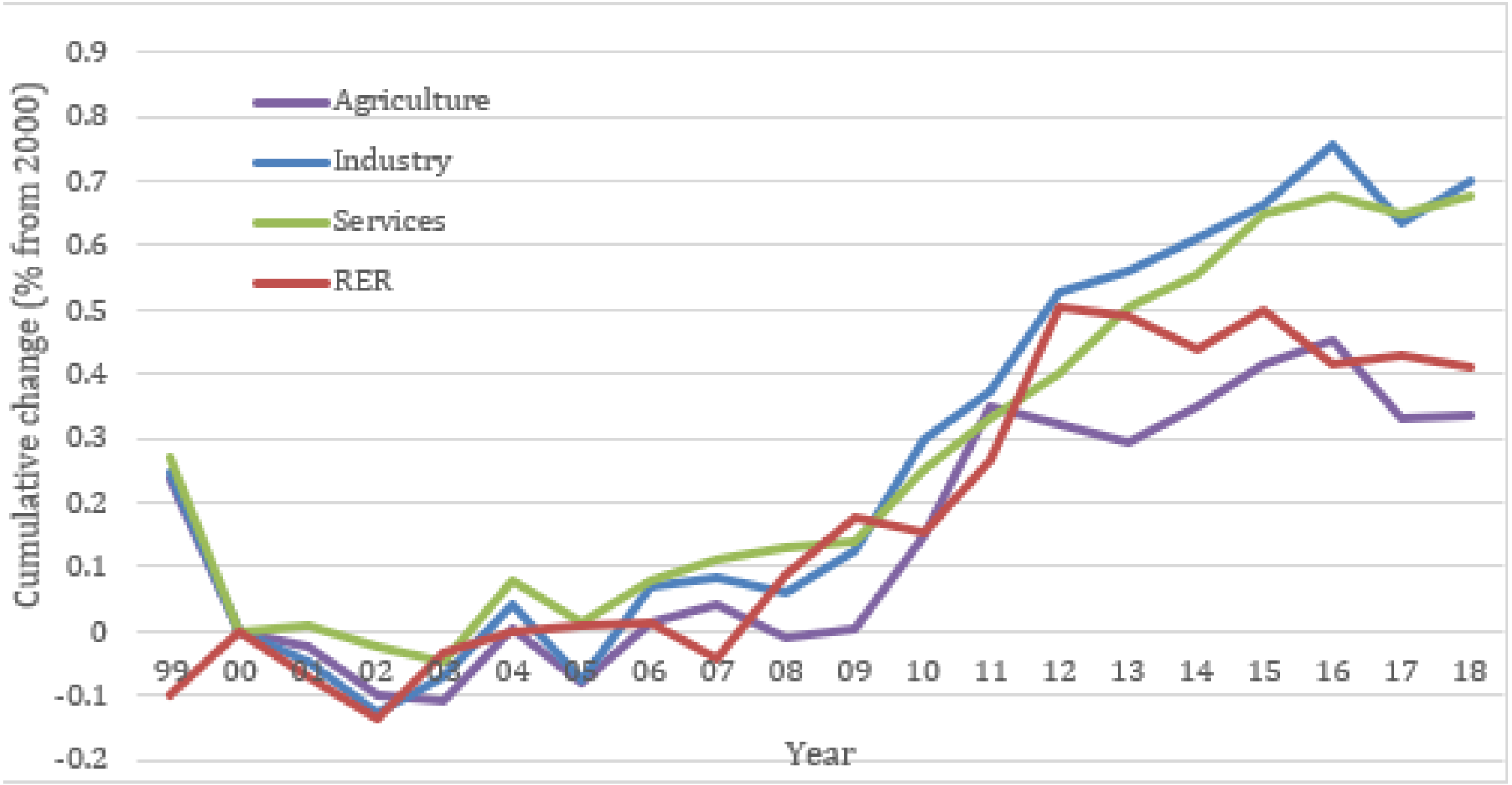
Cumulative growth in conditional real wage by sector: over the period 1999-2018



Results VI

- *Mining*
  - boom in mining sector real wages: rising monotonically from 2000 onwards
  - cumulative growth in year-on-year conditional real wage over 150% over 1999-2018
  - positive shocks to mining:
    - Commodities supercycle: 2003 – 2014
    - LNG investment phase 2010-2013 (steepens the gradient)
    - LNG production in commences mid-2014
    - other mining projects in PNG (e.g. Ramu Nickel in 2008)

Cumulative growth in conditional real wage by sector excluding mining: over the period 1999-2018



Results VII: cumulative change in crw relative to RER

- 1999 to 2002: the cumulative growth in the year-on-year conditional real wage is negative for all three sectors, down 20% between 1999-2000
  - inflation average 11% per annum over 1999 to 2002 (driven by depreciation of the Kina)
  - Recession: labor market slack, muted rises in W
- 2000-2012 all sectors: strong correlation between cumulative change in the RER and the cumulative change in the year-on-year conditioned real wage (only to 2011 for agriculture).
  - high dependence on imports in PNG, mpi 0.6 to 0.7
  - real depreciation reduces the real wage as the cost of imports rise
  - commodities price boom from 2003 => improvement in the terms of trade => higher expenditure => stimulus to the economy => increased growth, appreciates RER => ↑real wage

Results VII: cumulative change in crw relative to RER

- 2010-2013 LNG investment boom
  - Services and industry: sharp increase in the change in year-on-year conditional real wages
  - widespread stimulus to the economy driving competition for workers across the mining, services and industry sectors
  - Agriculture: sharp rise over 2009-2011, aligned with the LNG investment boom then plateaus from
  - agriculture sector firms competing for a different set of workers

- 2013-2016
  - Decoupling of cumulative growth in RER and CRW for services and industry from 2013
    - co-movement breaks down
  - businesses' beliefs of an ongoing boom persist,
    - continued to compete for labor pushing up real wages in services and industry sectors
    - accepting lower mark-up

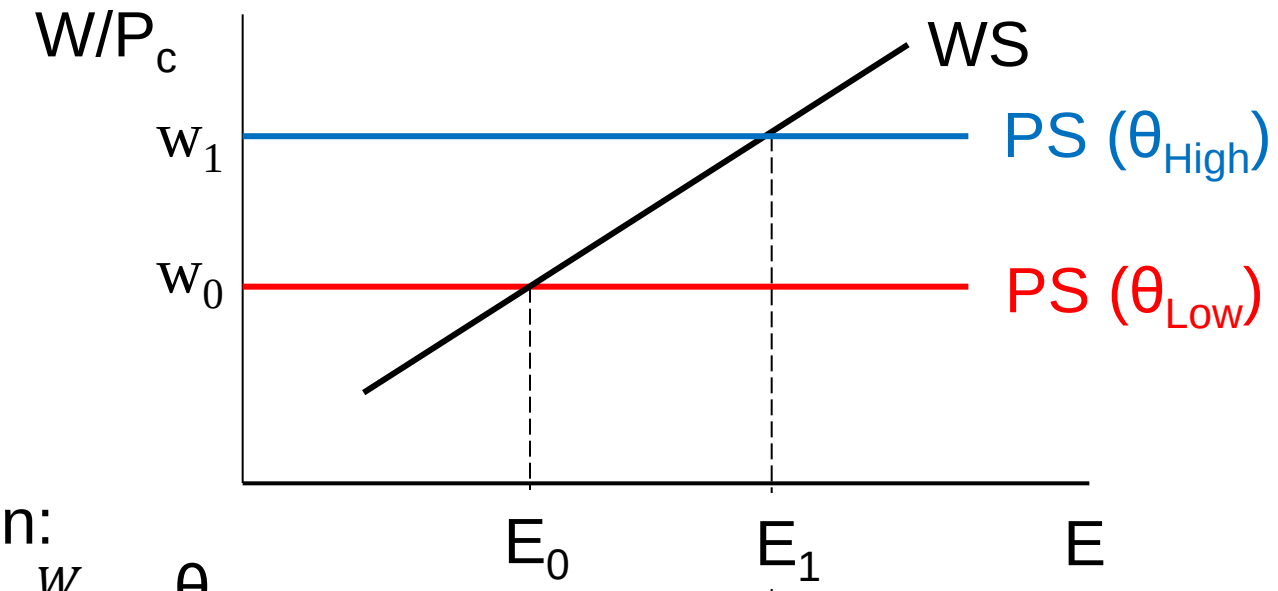
Results: summary

- New & comprehensive analysis of private sector wages in PNG over 1999-2018 using database close approximation of the population of private sector workers in the formal sector.
- Number of significant findings.
  i. conditional real wage growth robust over this period
  ii. variation across sectors of the economy: mining sector has highest conditional real wage growth, agriculture lowest.
  iii. conditional real wage growth (overall and by sector) is procyclical falling or slowing during busts and rising in booms.
  iv. men experience higher conditional real wage growth during booms but bear larger decreases during bust.
  v. Policy: high priority on determining and then attending to the drivers of productivity growth in the agricultural sector to improve real wage outcomes there.
- Standby for savings analysis

Policy and comments

- 4.5% p.a. conditional real wage growth over 20 years!
  - see it: believe it vs don't see it:don't believe it!
  - Wantok system: HHs feeding more people rather than accumulating human / physical capital
    - for growth, require $\uparrow \frac{K}{L}$, $\uparrow \frac{H}{L}$
- Keep RER strong: higher real wage (& higher equilibrium unemployment)
- Agriculture
- Impediments to women

Policy: equilibrium unemployment in the PNG Economy

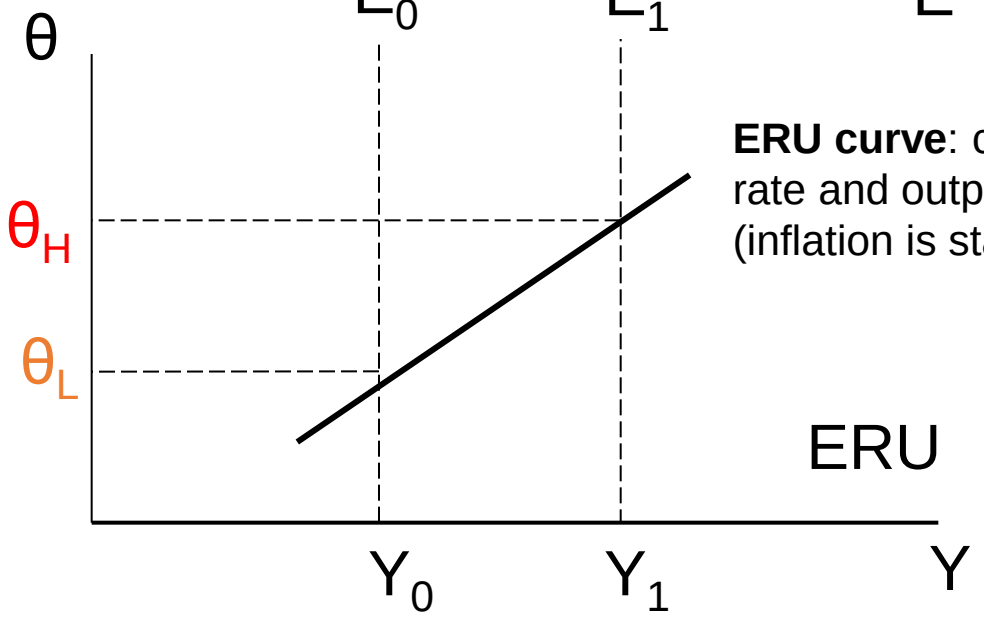


$RER = \theta = P/eP^*$

$\uparrow \theta \Rightarrow \uparrow \frac{W}{P}$

Policy implication:

Strong θ => high $\frac{W}{P}$



ERU curve: combinations of the real exchange rate and output at which labour market in equilibrium (inflation is stable)

$\theta_{Low} < \theta_{High}$

FE

- controlling for omitted variable bias due to unobserved heterogeneity when this heterogeneity is constant over time.
- There are two common assumptions made about the individual specific effect: the random effects assumption and the fixed effects assumption. The random effects assumption is that the individual-specific effects are uncorrelated with the independent variables. The fixed effect assumption is that the individual-specific effects are correlated with the independent variables. If the random effects assumption holds, the random effects estimator is more efficient than the fixed effects estimator. However, if this assumption does not hold, the random effects estimator is not consistent. The Durbin–Wu–Hausman test is often used to discriminate between the fixed and the random effects models

My assessment:

- A good paper
- Novel data: tick
- New theory: half tick
- Novel results: tick, limited by explanatory variables;
  - any funders want to fund a survey of subset of database?