An ‘Austrian’ Model of Global Value Chains

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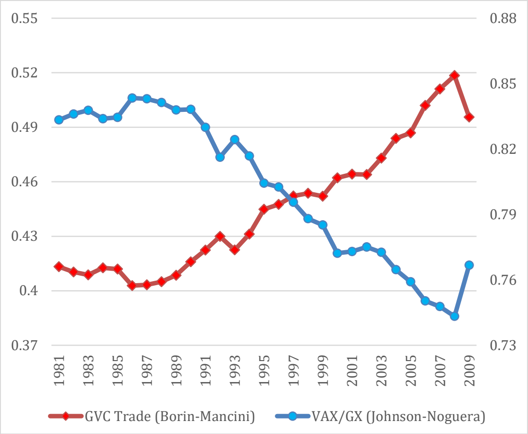
Two Salient Trends in World Economy



Rising GVC Participation

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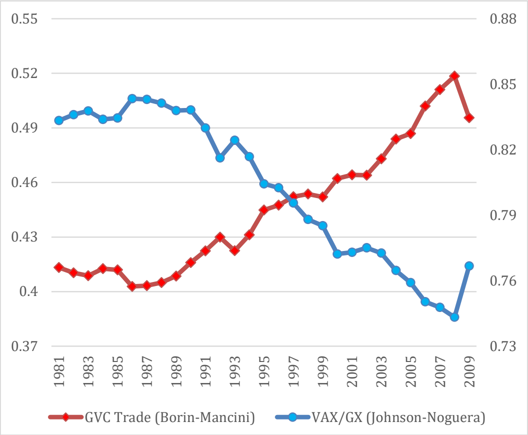

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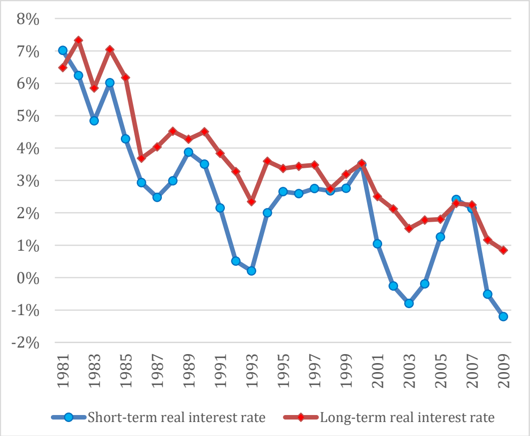

Declining Real Interest Rates

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- I build an 'Austrian' model of GVCs à la Böhm-Bawerk (1889), Wicksell (1934), and Findlay (1978), and study trade costs à la Antràs and de Gortari (2020)

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- Let me defer the discussion of the main results

Literature Review

- 'Austrian' concept of capital
  - Jevons (1871), Böhm-Bawerk (1889), Wicksell (1934), Metzler (1950), **Findlay (1978)**
- Sequential GVCs
  - Dixit and Grossman (1982), Sanyal and Jones (1982), Yi (2003, 2010), Harms et al. (2012), Antràs and Chor (2013), Costinot et al. (2013), Baldwin and Venables (2018), Kikuchi et al. (2018), Alfaro et al. (2019), Johnson and Moxnes (2019), Antràs and de Gortari (2020), Tyazhelnikov (2022)
- GVCs and Capital: Sposi et al. (2021), Ding (2022); Kim and Shin (2012)
- Trade and Time: Deardorff (2003), Evans and Harrigan (2005), Djankov et al. (2010), Hummels and Schaur (2013)
- Inventories, Just-in-Time: Alessandria et al. (2011), Ferrari (2022), Pisch (2022), Carreras-Valle (2022)

Closed-Economy Model

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- For now, I assume that capital markets are perfectly functioning, so agents borrow and lend at interest rate r

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- z_n denotes labor productivity at stage n, and $\alpha_n \in [0, 1]$ is value-added-intensity at n
- Final output is $y_N = \prod_{n=1}^{N} (z_n (t_n) L_n)^{\alpha_n \beta_n}$, with $\beta_n \equiv \prod_{m=n+1}^{N} (1 - \alpha_m)$

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  - $z_n'(t) > 0$ and $z_n''(t) / z_n'(t) < z_n'(t) / z_n(t)$

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- Lengthening production and delaying sales comes at cost of higher working capital needs

- Producers maximize their profits:

$$\pi_n = p_n \left(z_n(t_n) L_n\right)^{\alpha_n} \left(y_{n-1}\right)^{1-\alpha_n} e^{-rt_n} - wL_n - p_{n-1} y_{n-1}$$

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$$\alpha_n \frac{z_n'(t_n^*)}{z_n(t_n^*)} = r$$

- The length and labor productivity of all production processes are decreasing in r

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  - The optimal length t_n^* of a given stage is increasing in the value-added intensity α_n and time intensity ζ_n of stage n, and decreasing in the interest rate r
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- I obtain same results when solving the *lead-firm* problem (Antràs and de Gortari, 2020)

Closed-Economy Model: Equilibrium in the Labor Market

$$L_n = \frac{\alpha_n \beta_n e^{-r \sum_{m=n}^{N} t_m^*}}{\sum_{n'=1}^{N} \alpha_{n'} \beta_{n'} e^{-r \sum_{m=n'}^{N} t_m^*}} L$$

- More labor is allocated to relatively more important stages of production (high $\alpha_n \beta_n$) and also to relatively downstream stages (due to lower working capital needs)

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$$w = \kappa \prod_{n=1}^{N} \left(z_n \left(t_n^* \right) e^{-r \sum_{m=n}^{N} t_m^*} \right)^{\alpha_n \beta_n}$$

- Envelope theorem implies that the lower is the interest rate r, the higher is the wage w

Closed-Economy Model: Demand for Capital

- **Cumulated** working capital needs associated with stage-n labor costs are given by

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$$K^d = \sum_{n=1}^{N} wL_n \int_0^{\sum_{m=n}^{N} t_m^*} e^{rt} dt = \sum_{n=1}^{N} wL_n \frac{e^{r\sum_{m=n}^{N} t_m^*} - 1}{r}$$

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- Aggregate capital demand typically falls in interest rate r (certainly in log-linear case)
- Invoking the zero-profit condition at all stages, we obtain

$$y_N = \sum_{n=1}^{N} wL_n e^{r\left(\sum_{m=n}^{N} t_m\right)} = wL + rK^d$$

Closed-Economy Model: Supply of Capital and Capital-Market Equilibrium

- Supply of capital modeled as in Antràs and Caballero (2009, 2010)
  - Final good is only store of value
  - Agents save their income and consume right before dying (ρ governs impatience)

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with $\sigma = 1/(\rho - r)$ increasing in r and decreasing in ρ

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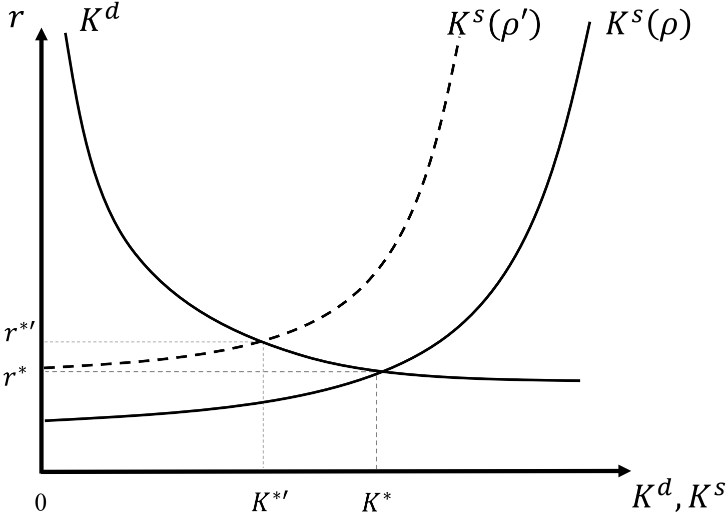
- Equilibrium interest rate pinned down à la Metzler (1951)

$$\frac{K^d}{wL} = \sum_{n=1}^{N} \frac{L_n}{L} \frac{e^{r\left(\sum\limits_{m=n}^{N} t_m^*\right)} - 1}{r} = \sigma(r, \rho) = \frac{K^s}{wL}$$

Equilibrium in the Capital Market



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- Under autarky, interest rate is lower ($r^H < r^F$) and wage is higher ($w^H > w^F$) at Home
- For now, I impose that factor price differences remain true under free trade

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- This is actually implied by no international borrowing and lending when n and $n+1$ are produced in different countries

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- Ratio of Home to Foreign prices at stage n is given by

$$\frac{p_n^H}{p_n^F} = \left(\frac{w^H}{w^F} \frac{z_n\left(t_n^F\right)}{z_n\left(t_n^H\right)} \frac{e^{r^H t_n^H}}{e^{r^F t_n^F}} \right)^{\alpha_n} \left(\frac{p_{n-1}}{p_{n-1}} \frac{e^{r^H t_n^H}}{e^{r^F t_n^F}} \right)^{1-\alpha_n}$$

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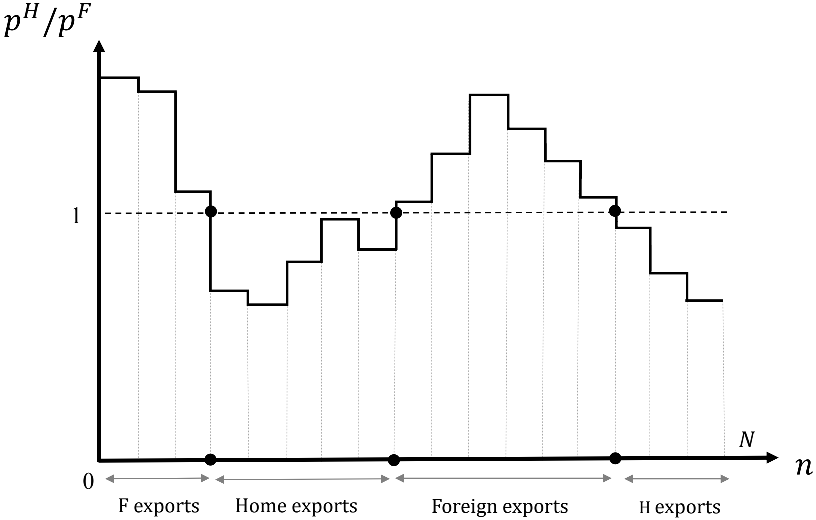
- In the log-linear case $\left(z_n\left(t_n\right) = \left(t_n\right)^{\zeta_n}\right)$ this reduces to

$$\frac{p_n^H}{p_n^F} = \left(\frac{w^H}{w^F} \left(\frac{r^H}{r^F} \right)^{\zeta_n} \right)^{\alpha_n}$$

- Comparative advantage is shaped by the relative size of the parameter ζ_n across stages
- So what matters is **relative time intensity**, not relative upstreamness

Comparative Advantage and Downstreamness



Trade Equilibrium with Factor Price Differences

- Assume we can partition the set of stages into two disjoint sets $\mathcal{N}^H$ and $\mathcal{N}^F$, with $\mathcal{N}^j$ being the set of stages in which country $j = H, F$ has comparative advantage

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- Labor-market clearing imposes

$$\frac{w^H}{w^F} = \frac{\sum\limits_{n \in \mathcal{N}^H} \alpha_n \beta_n e^{-\sum\limits_{m=n}^{N} \alpha_m \zeta_m}}{\sum\limits_{n \in \mathcal{N}^F} \alpha_n \beta_n e^{-\sum\limits_{m=n}^{N} \alpha_m \zeta_m}} \equiv B\left(v^*\right)$$

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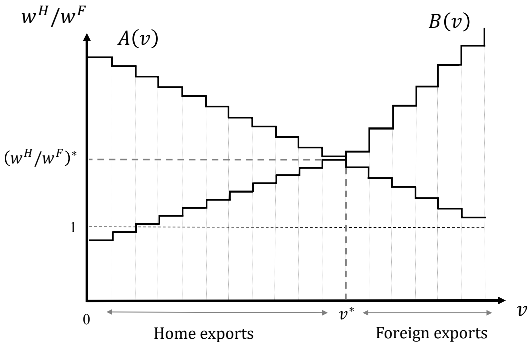
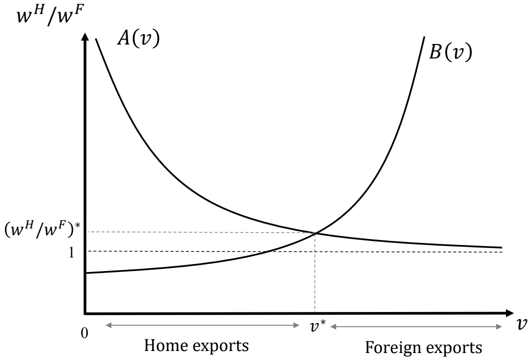


Discrete Number of Stages



Continuum of Stages

- Looks analogous to Dornbusch et al. (1977), but note that the $A(v)$ schedule is endogenous and shaped by differences in interest rates

Trade Equilibrium with Factor Price Differences

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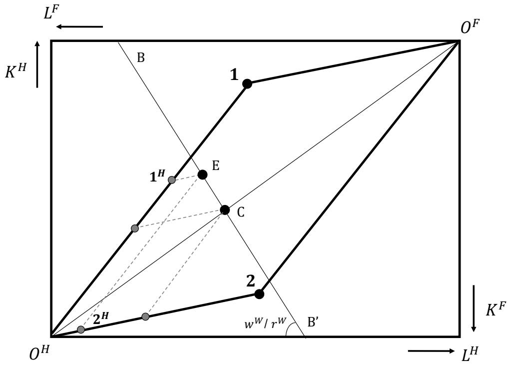
- Imposing capital-market clearing, we then get

$$\frac{r^F}{r^H} = \frac{\sigma\left(r^H, \rho^H\right)}{\sigma\left(r^F, \rho^F\right)} \times \frac{\sum_{n \in \mathcal{N}^F} L_n^F \frac{1}{\alpha_n}\left(e^{\alpha_n \zeta_n} - 1\right)}{\sum_{n \in \mathcal{N}^H} L_n^H \frac{1}{\alpha_n}\left(e^{\alpha_n \zeta_n} - 1\right)}.$$

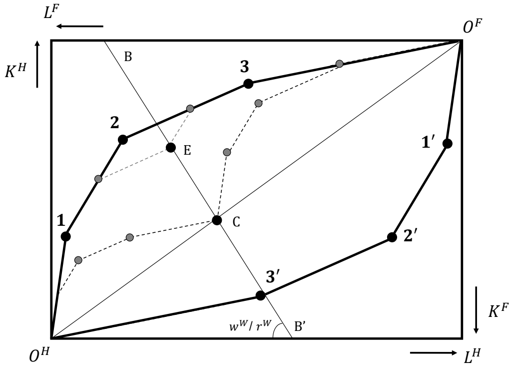
- As long as the right-hand side this equation is higher than one (e.g., small differences in K intensity across stages), the equilibrium will indeed entail a lower interest rate at Home

Trade Equilibrium with Factor Price Equalization

- What if there is FPE? Then labor productivity differences across countries vanish, and we are back to Heckscher-Ohlin model. Only capital intensity matters!



Two-Stage ($N = 2$) Case



Four-Stage ($N = 4$) case

Link to the Heckscher-Ohlin Model

- With FPE, model seemingly collapses to a standard two-factor Heckscher-Ohlin model
- Only capital intensity matters, which for each sector n we can write as

$$\frac{K_n^j}{L_n^j} = \frac{\lambda_n}{1-\lambda_n}\frac{w^j}{r^j},$$

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- But outside the FPE set, the model behaves **very** differently. Only time intensity matters!

$$\frac{p_n^H}{p_n^F} = \frac{a_{Ln}^H}{a_{Ln}^H}\frac{w^H}{w^F}, \quad \text{with}$$

$$a_{Ln}^j = \left(\frac{\alpha_n \zeta_n}{r^j}\right)^{-\zeta_n} \neq \left(\frac{\lambda_n}{1-\lambda_n}\frac{w^j}{r^j}\right)^{-\lambda_n}$$

Trade Costs and GVC activity

Costly Trade: Standard Iceberg Trade Costs

- This is not as simple as in the (seemingly) isomorphic Dornbusch et al. (1977) paper!
  - In DFS, goods for which relative costs are close to 1 become nontraded
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- I obtain similar 'bunching' effects as in sequential models of Harms et al. (2012) and Baldwin and Venables (2013)
- But dynamic programming (as in Antràs and de Gortari, 2020) leads to neater characterization
  - A sufficient but *not necessary* condition for Foreign producers at stage $n+1$ to choose Foreign as a source of inputs at stage n is

$$w^H \left(r^H\right)^{\zeta_n} > w^F \left(r^F\right)^{\zeta_n}$$

  - Thus, they may choose Foreign even when $w^F \left(r^F\right)^{\zeta_n} > w^H \left(r^H\right)^{\zeta_n}$, which indicates a disproportionate desire to bunch contiguous stages in the same location

Costly Trade: Time as a Trade Barrier

- By incorporating an explicit time value of money, framework can easily accommodate a temporal dimension of trade costs
  - Assume that shipping goods across borders involves an additional interval of time d

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- Insight #4: As long as no FPE, $\tau^{HF} < \tau^{FH}$.
  - Asymmetric bilateral trade costs consistent with evidence in Waugh (2010)

Financial Frictions and Trade Credit

Financial Frictions

- Suppose collecting interest involves monitoring costs m^j in country j
- Supply of capital at any point in time is now

$$(K^s)^j = w^j L^j \times \sigma\left(r^j, \rho^j, m^j\right),$$

with $\sigma^j = 1/\left(\rho^j + m^j - r^j\right)$ increasing in r^j and decreasing in ρ^j and m^j

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- But what if monitoring costs are relatively low between buyers and sellers? Trade credit

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- Insight #3: Trade Finance (i.e., borrowing and lending related to trade costs, not production costs) generates effects analogous to combination of trade credit and trade cost reductions

Conclusions

- I develop a stylized model of sequential production with N stages in which the time length of each stage is endogenously determined
- Letting the production process *mature* increases labor productivity, but it comes at the cost of higher working capital needs for firms
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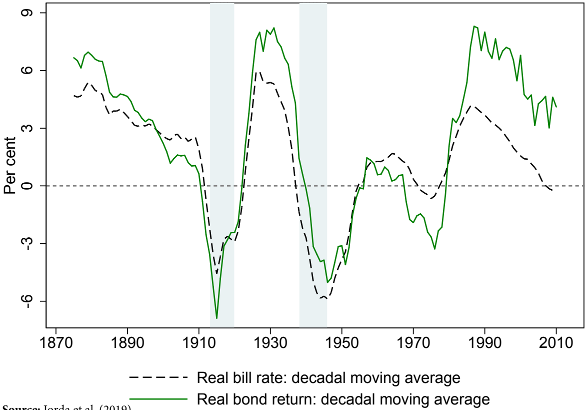
  - The effects of trade credit and trade finance
- Many potential extensions come to mind: scale economies, imperfect competition, financial frictions, firm heterogeneity, etc.

Low Interest Rates in Historical Perspective

Figure 3: *Trends in real returns on bonds and bills*



Source: Jorda et al. (2019)