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Integrated Labour Markets, Fragmented Welfare Systems: Cross-Border Work and the Measurement of Disposable Income

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Abstract

Cross-border labour markets integrate European regions economically, but welfare analysis remains constrained by national institutional systems. This paper develops a framework for measuring disposable income, redistribution, and inequality in functionally integrated but institutionally fragmented cross-border regions. We build on the European tax-benefit model EUROMOD to incorporate cross-border taxation, social insurance coordination, and family benefit allocation, and apply it to hypothetical household scenarios for workers residing in France and Belgium and employed in Luxembourg, the core of the Greater Region. We find that the disposable income consequences of cross-border employment are substantial and vary by household type and residence country. The cross-border premium is compressed at high earnings by France's exemption-with-progression mechanism, while Belgium's full exemption lets it persist and grow across the distribution. Modelling cross-border workers under residence-country rules alone likely overstates income equality, with the bias concentrated among households with children and at the lower end of the income distribution. These findings illustrate how territorial integration and welfare fragmentation coexist within functional cross-border regions. Combining country-specific EUROMOD models through a harmonised counterfactual approach, the paper offers a replicable method for measuring disposable income in cross-border contexts, and shows that inequality measurement remains tied to national welfare institutions even where labour markets operate at a regional scale.

JEL classification

J20, J38, J48, H24, H55

Keywords

cross-border workers, disposable income, microsimulation, tax-benefit systems, Luxembourg, Greater Region, income inequality, regional integration

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1 Introduction

Since the introduction of the free movement of workers with the creation of the European Economic Community (EEC) in 1957, a substantial number of individuals now reside in one country while working in another. While initially concentrated in limited numbers, cross-border labour mobility has expanded in recent decades, particularly in highly interconnected labour markets where economic activity extends beyond national borders (Edzes et al., 2022; Parenti and Tealdi, 2019). Cross-border labour commuting has become a key feature of regional integration in Europe, that not only integrates labour markets (Buch et al., 2009; Lundquist and Trippl, 2013), but also pushes the development of cooperation agreements that interconnects taxation system and access to social protection across countries (European Commission, 2022).

As cross-border labour creates this interactions between labour markets and tax-benefit systems across countries, it also complicates understanding of where net income is generated and how it is redistributed over border regions. Even tough workers may participate in the same functional labour market, their household disposable incomes depend on nationally distinct tax-benefit systems, eligibility rules, and bilateral arrangements tied to the country of residence or employment. As a result, economic integration can coexist with strong fragmentation in the way income losses, government transfers, and support are distributed across households and countries.

This institutional complexity has important implications in the disposable income distribution and the measurement of inequality within cross-border regions. Existing analyses of income inequality and redistribution generally rely on national frameworks in which taxes, benefits, and household incomes are assessed within a single institutional system. At the European level, the two main infrastructures used to analyse households welfare and the impact of tax-benefit policies are the European Union Statistics on Income and Living Conditions (EU-SILC) and the European tax-benefit microsimulation model EUROMOD (Sutherland and Figari, 2013). EU-SILC is residence-based as households are surveyed according to their country of residence, whereas EUROMOD is national, simulating the legal and institutional rules governing taxes, social insurance contributions, and cash transfers within national welfare systems. These two frameworks are coherent within nationally bounded contexts.

Such approaches were not originally designed to capture situations where households earn incomes across borders, and face mixed tax and transfer rules, governed by multiple jurisdictions. As an example, a worker may reside in France, earn labour income in Luxembourg, contribute to the Luxembourg social insurance system, and face tax obligations shaped by bilateral agreements between countries. Therefore, household disposable income for cross-border workers, not only depends on the characteristics of the household but also on the interaction between the laws in the country of residence, place of work, and cross-country coordination rules. In contexts with a high share of cross-border workers, standard tax-benefit analysis struggles to fully capture institutional interactions since the residence-based principle in most household surveys does not necessarily coincide with the jurisdiction governing taxation and social insurance contributions.

This issue is particularly relevant in the Luxembourg-centred *Greater Region* , one of the most integrated cross-border labour markets in Europe composed of Saarland and Rheinland-Pfalz in Germany, Lorraine in France, Wallonia in Belgium, and Luxembourg. Luxembourg's strong economy and status as a financial hub in Europe attracts international businesses and many professionals. Since the creation of the EEC, Luxembourg has developed into a major centre of cross-border employment, with cross-border workers accounting in 2025 for almost half of total employment, equivalent to more than 233,000 workers commuting daily from Belgium (approx. 25%), France (approx. 50%), and Germany (approx. 25%). This paper focuses on Luxembourg since the country employs the highest share of cross-border commuters relative to its work force when compared to other countries in the European Union and within the *Greater Region* (van der Valk, 2018). In this context, economic integration extends across national borders, while taxation and social protection systems remain fragmented across countries through different bilateral or

Pan-European agreements.

Meanwhile, the growing literature on cross-border labour mobility in Europe focuses on a wide range of economic, social, and institutional dimensions of commuting (Paul et al., 2026) that extend well beyond the fiscal and welfare analysis that we follow in this paper. In Luxembourg, a few studies can be highlighted. At the regional level, Lamour (2020) shows that the *Greater Region* centred on Luxembourg has developed a distinctive model of identity building tied to functional economic integration, with the increasing concentration of cross-border employment in Luxembourg generating spatial asymmetries between the residents in the Grand Duchy and its neighbours in France, Belgium, and Germany. From a mobility perspective, Järv et al. (2026) confirm that the *Greater Region* constitutes the most integrated cross-border labour market in Europe. Using geolocated social media data, the authors characterised the region with the most pronounced pattern of habitual workday cross-border mobility among all internal EU border regions.

Beyond the Luxembourg context, other studies have focused on studying cross-border commuting decisions and suggest that this patterns are strongly driven by policies that shape disposable income instead of gross wages alone. For example, in the Czech-Bavarian border region, Trager (2026) shows that social benefits such as the child allowances in the country of employment constitute the strongest monetary incentive for cross-border commuting. In contrast, rising commuting costs and exchange rate dynamics can substantially erode the net financial advantage and decrease the incentives to commute. Focusing in the US context, a growing body of literature examines how policy discontinuities between bordering states, such as minimum wage or taxes, explain across-state commuting (Kuehn, 2016; McKinnish, 2017; Ranjan et al., 2022). One example that explicitly highlights the role of taxes is the work of Agrawal and Hoyt (2017). The authors combine theory, household-level data and the NBER's TAXSIM model for federal and state income taxes to demonstrate how tax differentials distort commuting patterns, especially among high-income households. Complementarily, Shirley (2018), using data from the American Community Survey, shows that changes in the minimum wage and the Earned Income Tax Credit supplements across states generated sizeable and significant effects on cross-border commuting. These findings closely mirrors the institutional mechanisms examined in our paper, where social benefits, and differential tax burdens generate substantial variation in household disposable income across comparable workers and thereby shape cross-border commuting decisions.

Additionally, research on individual motivations for cross-border commuting highlights that non-economic factors play an equally important role alongside wage/income differentials. Trager and Jelínková (2026) show, in the context of the Czech-Bavarian border region, that personal networks serve as the primary recruitment channel for employers of cross-border commuters, allowing firms to fill vacancies at low cost and without facing language barriers, suggesting that cross-border labour markets are partly self-reinforcing social structures instead of being just the result of economic incentives.

Taken together, these contributions establish that the welfare consequences of cross-border employment are shaped simultaneously by individual characteristics, institutional frameworks in both the country of residence and the country of employment, and the coordination rules governing taxation, social insurance, and family benefits, precisely the mechanisms that the present paper seeks to model and quantify within a microsimulation framework.

Despite the increasing numbers of cross-border labour mobility across Europe, its implications for welfare analysis and the measurement of disposable income remain relatively unexplored. Existing applications of EUROMOD and EU-SILC have made substantial contributions to the analysis of inequality and redistribution within countries. However, little attention has been devoted to how cross-border workers are represented within tax-benefit microsimulation frameworks when tax liabilities, social insurance contributions, and benefit entitlements are shaped simultaneously by the country of residence and the country of employment. Recent work highlights that microsimulation tools and survey infrastructures are largely designed for resident populations, while dedicated modelling frameworks for cross-border commuter households remain limited (Liégeois, 2025). In practice, nationally bounded modelling assumptions often

imply an alignment between residence, taxation, and social insurance rules, assumptions that becomes increasingly restrictive in highly integrated cross-border labour markets.

This paper addresses this gap through three contributions. First, it contributes to our understanding of how tax-benefit rules operate in a cross-border context by examining how cross-border tax-benefit interactions shape household disposable income within integrated labour markets. We use a set of harmonised hypothetical household scenarios designed to isolate the institutional effects of cross-border employment arrangements. By varying the country of residence, place of work, household composition, and employment configuration, we examine how interactions between national tax-benefit systems generate disposable income differences across otherwise comparable households.

Second, the paper makes a methodological contribution by incorporating cross-border taxation, social insurance arrangements, and cross-border rules for cash benefits into the simulation of household disposable income, building on the European EUROMOD framework. The contribution is not to modify the underlying survey or EUROMOD architecture, but to develop a modelling infrastructure that combines country-specific tax-benefit models in order to better capture the institutional realities associated with cross-border work. Using stylised counterfactual household scenarios, we show that ignoring cross-border institutional arrangements leads to systematic measurement error in disposable income, which in turn affects estimates of inequality and redistribution within integrated cross-border labour markets. The proposed framework therefore contributes to the refinement of regional inequality measurement in cross-border regions.

Third, the paper contributes to regional studies by demonstrating that inequality measurement remains tied to national welfare institutions even when labour markets operate at a regional scale. We show that cross-border institutional arrangements can generate systematic measurement error in disposable income and redistribution indicators, suggesting that conventional approaches may mischaracterise socio-economic disparities within integrated cross-border regions.

The paper is structured as follows: Section 2 describes the institutional settings for cross-boarder workers. Section 3 describes the methodology used in this paper. Results of our analysis are presented in Section 4, while Section 5 concludes.

2 Institutional insights about cross-border workers in France and Belgium

The institutional interactions between the work and residence countries play a central role in shaping household disposable income and redistribution outcomes. A combination of Luxembourg, French/Belgium, and European Union rules determines income taxation, social security contributions, and benefit entitlements for Cross-border workerS and their households. The section compares the institutional setting governing cross-border workers residing in France and Belgium and employed in Luxembourg organised by different dimensions: income taxation, social security contributions, family benefits, and the legal framework.

We highlight the cases where the rules are governed by the shared EU coordination architecture or by a specific bilateral settlement is in place. This analysis shows the potential implications from these institutional differences between the Belgian and French systems and its potential distributional outcomes.

2.1 Income taxation

Income taxation is the main channel through which the institutional treatment of cross-border workers differs between France and Belgium.In general, labour income earned in Luxembourg is taxable in Luxembourg under double taxation agreements, regardless of the worker's country of residence. Cross-border workers are subject to withholding tax at source and are generally taxed individually under the applicable Luxembourg tax class. Joint taxation with the spouse's income earned abroad applies by default in France. In Belgium, however, taxes only on Belgian-source income, but certain cross-border

households can request an optional assimilation to resident taxation if income-threshold conditions are met, allowing access to resident-style deductions and benefits.

The main difference between France and Belgium income taxation rules for cross-border workers is the treatment of foreign earned income in the residence-country taxation system. France applies an exemption with progression mechanism (*"exonération avec progression"*): Luxembourg earnings are exempt from direct French taxation, but they are included in the total household income to determine the effective marginal tax rate, which is then applied to French-taxable income. As a consequence, the earnings coming from Luxembourg indirectly affect the tax burden on French income, while creating a strong cross-border progressivity channel at the household level.

For cross-border workers living in Belgium, earnings from Luxembourg are less integrated from a fiscal point of view. Under the Luxembourg-Belgium double taxation agreement, employment income from Luxembourg is exempt from taxation in Belgium, while applying a full exemption without progression. This means that incomes earned in Luxembourg are neither taxed in Belgium nor taken into account for determining the applicable tax rate on Belgian-taxable income. Therefore, there is cross-border progressivity channel in the Belgian tax system since income taxation is fully independent of Luxembourg earnings.

This two different rules implies that similar cross-border households may face different disposable-income depending on the country of residence (France versus Belgium). For a French-resident household, the tax system preserves a residual interaction between residence and work across the border. While, for a Belgian-resident household, that interaction is weaker. For the purpose of the present analysis, the Belgian case is the most useful benchmark to fully isolates the effect of cross-border employment from the additional layer of tax progression that is present in France.

2.2 Social security contributions

While income taxes are governed by bilateral agreements, the social security part is governed by European Union coordination rules. The general governing principle states that residents of both France and Belgium who work in Luxembourg are insured under the Luxembourg social security system. Cross-border workers pay employee social security contributions in the country of work, as well as their employers. These contributions cover health insurance, pensions, unemployment insurance, and other contributory benefits.

At the same time, the system contains an exception linked to telework. Under the default EU social security coordination rule (Regulation (EC) No. 883/2004), if less than 25% of working time is carried out in France or Belgium, social security continues to follow the Luxembourg system. Once the number of days in telework reaches at least 25% without the framework agreement, this affiliation shifts to the residence country, making France or Belgium the competent party. However, a bilateral framework agreement on telework between these countries can raise the threshold as follows: Luxembourg remains competent when telework is below 50%, but affiliation moves to the residence country once telework reaches at least 50%. The framework agreement applies if the worker is not self-employed, he or she teleworks only from the country that co-signed the agreement, does no perform other work activities in the residence country outside the telework activity, does not regularly work in additional countries, and the employer has obtained the A1 certificate.

The telework rules affect both cross-border workers living in France and Belgium in the same formal way, but not necessarily with the same financial consequences. These changes in social security affiliation can potentially create differences in the base and rate of contribution. In France, a change in social security affiliation may occur alongside a very complex system of multiple contribution bases and ceilings with an already existing cross-border tax interaction due to the exemption with progression. Belgium, by contrast, combines the same social-security contribution base, and fewer ceilings with a tax system that does not transmit Luxembourg earnings into domestic progression. Therefore, the two regimes differ not in whether telework matters, but in how many channels are activated once telework changes the locus of

social protection.

The presented simulations assume that telework is zero or within the maximum permitted thresholds for telework according to the specific bilateral treaties[1].

2.3 Family benefits and residence-based transfers

One strong institutional difference between France and Belgium is in the treatment of family benefits and other residence-based transfers. Family benefits are allocated according to EU coordination rules. If only one parent works and employment takes place in Luxembourg, Luxembourg is generally the competent state for family benefits. When both parents work and one parent is employed in France or Belgium, the country of residence becomes the primary competent state. However, Luxembourg may pay a differential supplement if its family benefit level exceeds that of France or Belgium.

The difference emerges more clearly in the treatment of means-tested and residence-based transfers, which are provided by the country of residence[2]. Luxembourg employment income, although exempt from French taxation, is typically taken into account when assessing eligibility and benefit amounts, thereby affecting household welfare through the French benefit system. In Belgium, by contrast, residence-based transfers are also provided by the residence country, but Luxembourg earnings do not feed into domestic tax progressivity. This makes the Belgian system more discontinuous from the Luxembourg tax base, while the French system preserves a stronger link between foreign earnings, family benefits and in consequence the overall household budget constraint. Taken together, these institutional differences suggest that cross-border employment is likely to be more tightly translated into disposable income effects for households residing in France than for otherwise comparable households residing in Belgium.

2.4 Legal framework

The institutional setting is defined by the bilateral double taxation convention between Luxembourg and France, which allocates taxing rights over labour income, and by EU Regulation (EC) No 883/2004 and Regulation (EC) No 987/2009, which coordinate social security systems. EU rules on the coordination of family benefits establish binding priority rules for benefit entitlement in cross-border situations. Together, these legal provisions create a highly fragmented fiscal and social environment for Luxembourg cross-border workers residing in France.

Meanwhile, the treatment of Belgian-resident cross-border workers is based on the bilateral double taxation convention between Luxembourg and Belgium, EU social security coordination regulations (Regulations (EC) No 883/2004 and No 987/2009), and EU rules on the coordination of family benefits. Compared to France, the absence of an exemption-with-progression mechanism in Belgium leads to weaker fiscal interactions between Luxembourg employment income and residence-country taxation.

3 Methodology

This paper evaluates how cross-border employment affects the measurement of disposable income in microsimulation models. Our central argument is that standard single-country microsimulation models may generate systematic measurement error in disposable income when cross-border workers are observed in the microdata of one country but are taxed and insured under the rules of another country.

[1] Beyond these thresholds, taxation rights may shift to the employee's country of residence. The relevant limits are 29 days for France, 34 days for Belgium, and 19 days for Germany, after which the residence state may tax the corresponding employment income.

[2] Under telework conditions, exceeding social security thresholds may shift affiliation to the residence country, which can become primarily responsible for child allowances (with Luxembourg potentially paying only a top-up or nothing, depending on the scenario.

Most tax-benefit microsimulation models, including EUROMOD, are constructed as single-country policy simulators. They apply the tax and transfer rules of the country in which the household is observed. However, in border regions, a non-negligible share of individuals reside in one country while working and paying income tax and social contributions in another country. If such individuals are simulated solely under residence-country rules, their tax liabilities and entitlements may be misrepresented.

To quantify this potential bias, we construct counterfactual household scenarios using EUROMOD, based on policies of 2025 (Sutherland and Figari, 2013; Bursens et al., 2026; Bouvard and Trannoy, 2026; Sologon et al., 2026). Because EUROMOD operates separately for each country, cross-border situations cannot be simulated directly within a single policy spine. We therefore implement a harmonised counterfactual approach based on hypothetical twin households.

Our analysis is based on three stylised household types that are designed to capture the most prevalent family structures among cross-border workers. The first is a single-earner household without children, consisting of one adult whose gross monthly labour income varies from EUR 3,000 to EUR 7,500 in steps of EUR 500. The second is a single-parent household with two dependent children, with the same income range for the working adult. The third is a two-earner household with two dependent children, where one partner works in Luxembourg as a cross-border worker and earns between EUR 3,000 and EUR 7,500 per month, while the second partner works in the country of residence at a fixed gross monthly income of EUR 3,000. In all three household types the children are assumed to be of school age.

The income range is chosen to reflect the observed gross income distribution of cross-border workers reported in Table A-1 using the 4th wave Household Finance and Consumption Survey for Luxembourg residents and Cross-Border workers (Mathä et al., 2024). The bottom quintile of French cross-border workers earns approximately EUR 2,225 per month and the bottom quintile of Belgian cross-border workers approximately EUR 2,950 per month, meaning that our lowest income reflects more or less the lowest-earning cross-border workers. The upper bound of EUR 7,500 corresponds roughly to the boundary between the third and fourth quintile of the total cross-border workforce, implying that our simulation covers the large majority of the cross-border income distribution.

For each household type h, we simulate identical demographic characteristics and gross earnings under multiple institutional settings:

- Residence and work in the country of domicile (baseline scenario),
- Residence in France or Belgium with employment in Luxembourg (cross-border scenario),
- Residence and work in Luxembourg.

Let Y_h^{RES} denote disposable household income under the residence-country system ($RES \in \{FR, BE\}$), Y_h^{LU} the income when residing and working in Luxembourg, and Y_h^{CB} the cross-border scenario.

The cross-border income is constructed by combining model outputs from two country simulations. For a household with members $i \in h$ and one cross-border worker c, we define:

$$Y_h^{CB} = \sum_{i \neq c} Y_i^{RES} + Y_c^{LU}. \tag{1}$$

This implies that:

- The cross-border worker is taxed and insured under Luxembourg rules,
- Non-working or domestically employed household members remain under residence-country rules,
- Residence-based benefits (e.g. social assistance) remain governed by the domicile country.

In more detail, the cross-border simulation is constructed by combining outputs from two separate EUROMOD country models rather than modifying either model internally. For a household in which one member works in Luxembourg as a cross-border commuter, we run two simulations in parallel. The cross-border earner is processed through the Luxembourg EUROMOD spine, which applies Luxembourg income tax, social insurance contributions, and Luxembourg-linked family benefits to that earner's gross labour income. The remaining household members, typically a non-working or domestically employed spouse, are processed through the residence-country spine, which applies French or Belgian tax and transfer rules to their income.

The two outputs are then combined at the household level to produce a single disposable income figure, as defined in equation (1). This approach respects the institutional reality that the cross-border earner's tax and social insurance obligations are determined by the country of employment, while residence-based transfers and the domestic taxation of any residence-country income remain governed by the country of domicile. Family benefits are assigned to the competent state according to EU coordination rules: where Luxembourg is the primary competent state, the Luxembourg family benefit is included in the Luxembourg simulation output; where the residence country is primary and Luxembourg pays only a differential top-up, the top-up is added separately.

The baseline scenario in which both earners working in the country of residence, is then produced by running the household entirely through the residence-country spine. The Luxembourg resident scenario is produced by running the household entirely through the Luxembourg spine, treating both earners as Luxembourg residents and workers. The three scenarios differ only in which institutional rules are applied to which earner, with gross earnings held fixed throughout. As a result, differences in disposable income across scenarios provide a clean measure of the institutional effect of cross-border employment, free from any confounding differences in gross pay or household composition. Based on these institutional settings, disposable household income is calculated as:

$$Y_h = \sum_{i \in h} \left(E_i + B_i - T_i - SIC_i \right), \tag{2}$$

where E_i denotes gross earnings, T_i income taxes, SIC_i social insurance contributions, and B_i cash benefits. This framework allows us to decompose the differences in disposable income into tax, contribution, and benefit components.

We then compare:

$$\Delta Y_h^{CB-RES} = Y_h^{CB} - Y_h^{RES}, \tag{3}$$

$$\Delta Y_h^{LU-CB} = Y_h^{LU} - Y_h^{CB}. \tag{4}$$

The first difference isolates the effect of working in Luxembourg while holding residence fixed. The second isolates the effect of residence while holding workplace fixed.

The decomposition of these differences in disposable incomes in the contribution of the tax-benefit instruments is expressed as:

$$\Delta Y_h^k = \Delta B_h^k - \Delta T_h^k - \Delta SIC_h^k, \qquad k = CB - RES; LU - CB. \tag{5}$$

The decomposition graphs in the results reflect the values of ΔB, ΔT and ΔSIC.

The key contribution of this approach is to demonstrate the magnitude and direction of the bias that arises when cross-border workers are simulated entirely under residence-country tax rules. In standard microsimulation applications, cross-border workers who appear in the data of France or Belgium are often treated as if they were taxed domestically. This can distort income tax liabilities, social contribution payments, eligibility for means-tested transfers, and measured disposable income and inequality.

Our counterfactual design therefore provides an upper-bound estimate of the structural modelling error

that emerges when cross-border institutional coordination rules are ignored.

The analysis is static and partial equilibrium. Behavioural responses, migration decisions, and dynamic lifecycle effects are not modelled. The focus is exclusively on institutional differences embedded in tax-benefit legislation.

4 Results

The Greater Region labour market is institutionally integrated in terms of employment, but fragmented in terms of welfare. How that fragmentation translates into household disposable income depends on the worker residence country, and the household composition. We examine this by household type, in order of increasing institutional complexity:

- single individuals without children, where the absence of family benefits isolates the pure tax mechanism;
- single-parent households, where family benefit coordination rules interact with taxation; and
- two-earner households with children, where joint taxation, labour income composition, and family-related transfers combine to shape the disposable income gap.

For each household type, we present two comparisons that isolate distinct institutional effects. The workplace effect compares residence and employment in the country of domicile (the baseline) with residence in France or Belgium combined with employment in Luxembourg (the cross-border scenario), holding residence fixed. The residence effect compares the cross-border scenario with residence and employment in Luxembourg, holding the workplace fixed in Luxembourg. Each comparison is presented in two complementary forms: a decomposition of the disposable income difference into taxes, social insurance contributions, family benefits, and other benefits, and the underlying disposable income levels under each scenario. Section 4.4 closes by assessing the distributional consequences of ignoring cross-border rules at the level of the full Luxembourg workforce.

4.1 Single households without children

The simulated household consists of one adult without children. As family benefits are absent by construction and residence-based means-tested transfers play a negligible role, this household type isolates the pure tax mechanism through which cross-border employment affects disposable income, with social insurance contributions as a secondary mechanism.

Workplace Effect

Figure 1a and Figure 1b decompose disposable income differences between cross-border and domestic employment into its tax, social insurance contribution, and benefit components, separately for French and Belgian residents. The corresponding disposable income levels under cross-border and domestic employment behind these differences are reported in Figure 2a and Figure 2b.

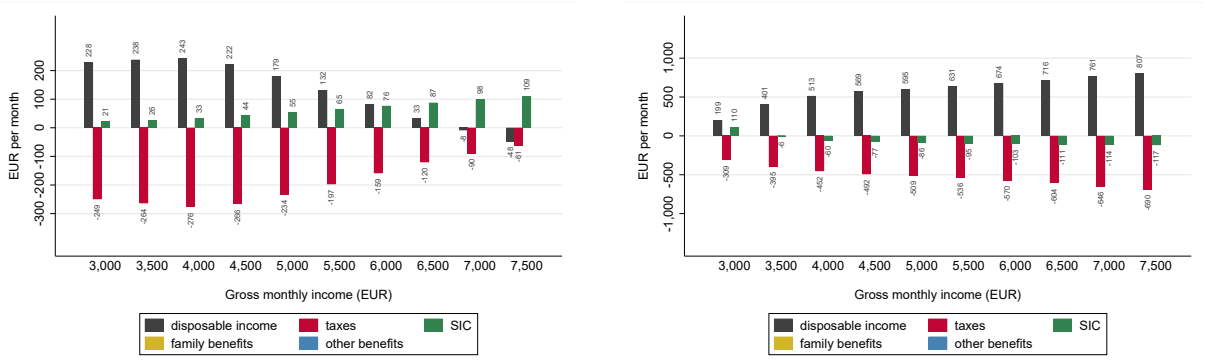
For French residents, the cross-border premium reaches EUR 228 per month at the lowest earnings level considered (EUR 2,483 of disposable income compared with EUR 2,255 under domestic employment) and follows a non-monotonic pattern across earnings levels: it declines, becoming negligible in the upper-middle of the earnings distribution, and then reverses at the top, where the domestic scenario exceeds the cross-border one by EUR 48 at EUR 7,500. The tax mechanism drives this pattern. The tax advantage is largest at the bottom of the distribution, where cross-border workers pay EUR 249 to EUR 276 less per month than comparable workers taxed in France, and gradually erodes as the exemption-with-progression

mechanism feeds Luxembourg earnings into the marginal rate applied to any French-source income. Social insurance contributions (SIC) pull in the opposite direction. Their contribution increases from EUR 21 for households with gross earning of EUR 3000, to EUR 109 for those at the top with EUR 7500. Ultimately SIC dominates over the tax effect and they lead the reversal in disposable income at the upper end of the distribution.

For Belgian residents, the cross-border premium grows monotonically across the distribution, rising from EUR 199 (EUR 2,284 versus EUR 2,483) at EUR 3,000 in gross earning, to EUR 807 (EUR 4,044 versus EUR 4,851) at EUR 7,500. Cross-border workers pay EUR 309 to EUR 690 less in taxes than comparable workers fully taxed in Belgium. The tax advantage widens steadily as Belgium's full exemption-without-progression keeps Luxembourg earnings out of the Belgian tax schedule and prevents any attenuation. The social insurance channel operates against the cross-border household only at the lowest earnings level, where the Belgian work bonus reduces employee contributions for low-wage residents and produces a offset of EUR 110 in the SIC for the household whose gross earning are EUR 3,000. The effect dissipates from EUR 3,500 in gross earnings onwards.

The comparison between France and Belgium for singles without children reveals the structural importance of the residence-country tax system. In this case, the cross-border premium is determined only by the taxation of labour income, but its pattern across the earnings distribution depends on how the residence country treats foreign income. In France, the exemption-with-progression acts as an attenuation mechanism that gradually offsets Luxembourg's tax advantage and, together with the increasing SIC differential, it reverses the premium. In contrast, the full exemption-without-progression in Belgium removes this attenuation, so that the difference between Luxembourg and Belgian tax schedules translates directly into an increasingly large disposable income advantage.

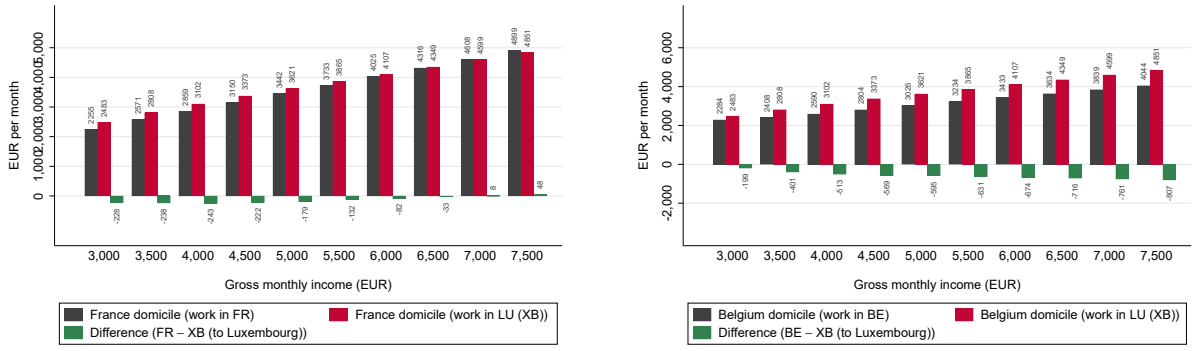
Figure 1: Decomposition of disposable income differences between single cross-border workers residing in France and Belgium versus individuals working in the country of residence.



(a) France

(b) Belgium

Figure 2: Disposable income comparison for single cross-border workers residing in France and Belgium versus individuals working in the country of residence.



(a) France (b) Belgium

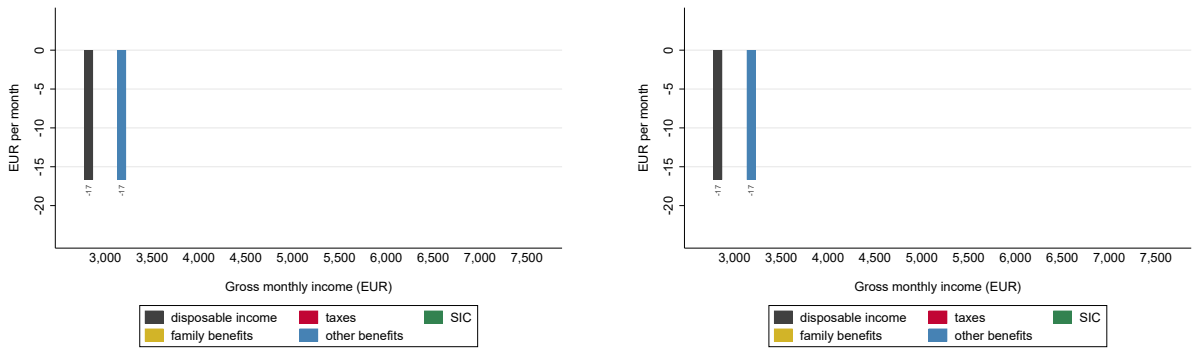
Residence Effects

Figures 3a and 3b decompose the disposable income difference between cross-border workers and Luxembourg residents. Figures 4a and 4b show the corresponding income levels resulting in these differences.

Institutional differences almost vanish for this household type. Luxembourg residents have EUR 17 more disposable income than cross-border workers at EUR 3,000, and the two scenarios produce identical disposable income at all higher earnings levels. For single individuals without dependents, residence-based transfers play essentially no role: the household does not qualify for family benefits, and means-tested support drops to zero above the lowest earnings level. The cross-border earner is taxed under Luxembourg rules in both scenarios, so disposable income is determined by the Luxembourg tax schedule applied to labour income alone.

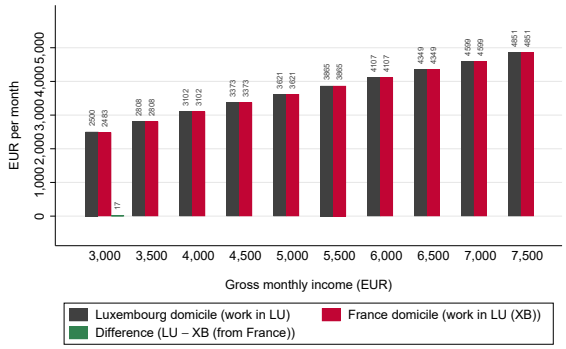
The absence of a residence effect for this household type is informative, showing that the Luxembourg tax-benefit system applies in the same way regardless of whether the worker resides in Luxembourg or commutes from abroad, once family benefits and residence-based means-tested transfers are removed from the picture. Therefore, any residence effect observed for more complex household types must come from these two channels instead of differences in the taxation of labour income.

Figure 3: Decomposition of disposable income differences between single cross-border workers and Luxembourg residents.

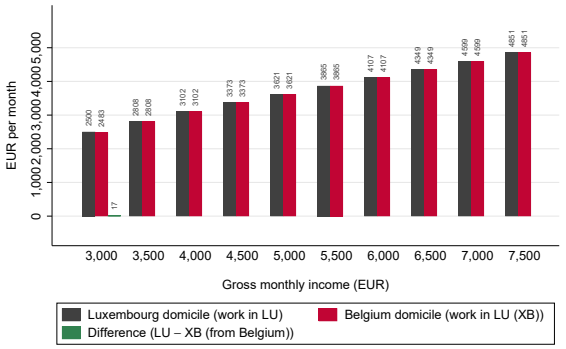


(a) France (b) Belgium

Figure 4: Disposable income comparison for single cross-border workers versus individuals residing and working in Luxembourg.



(a) France residence vs Luxembourg residence



(b) Belgium residence vs Luxembourg residence

Measurement bias

For single individuals without children, the workplace determines the tax outcome and the residence-country contribution is essentially zero. Simulating these workers under residence-country rules misrepresents their disposable income by the full magnitude of the workplace effect: EUR 199 to EUR 807 per month for Belgian residents across the distribution, and a more modest and earnings-dependent error for French residents that ranges from EUR 228 at the bottom to a sign reversal at the top. The bias has two analytically distinct features that will affect also more complex household types. First, it is asymmetric across residence countries because of the underlying tax design: larger and monotonically growing for Belgian residents, where no attenuation operates, and smaller and earnings-dependent for French residents, where exemption-with-progression compresses the bias at higher earnings. Second, the bias is purely tax-driven for this household type, since family benefit coordination and residence-based transfer differentials play no role. This establishes the baseline against which the bias for households with children, where these additional channels activate, can be assessed.

4.2 One-earner households with children

The simulated household consists of one adult and two dependent children. For this household type, family benefits become a second institutional channel through which cross-border employment affects disposable income. Since family benefits are largely determined by the country of employment for cross-border workers, households with children receive transfers linked to Luxembourg employment. Social insurance contributions remain a secondary channel, operating in the same direction as for singles without children.

Workplace Effect

Figure 5a and Figure 5b decompose disposable income differences between cross-border and domestic employment into its tax, social insurance contribution, family benefit, and other benefit components, separately for French and Belgian residents. The corresponding disposable income levels under cross-border and domestic employment behind these differences are illustrated in Figure 6a and Figure 6b.

The cross-border premium for French residents reaches EUR 928 per month at the lowest earnings level (EUR 3,754 of disposable income compared with EUR 2,826 under domestic employment), followed by a declining and further by a reversed pattern at the top of the distribution. Two mechanisms jointly drive the premium at the bottom. The tax advantage accounts for EUR 473 (15% of gross income): cross-border workers are taxed under Luxembourg rules, and the Luxembourg schedule is more favourable at these earnings levels. The family benefit channel adds EUR 487 (16%), reflecting the gap between

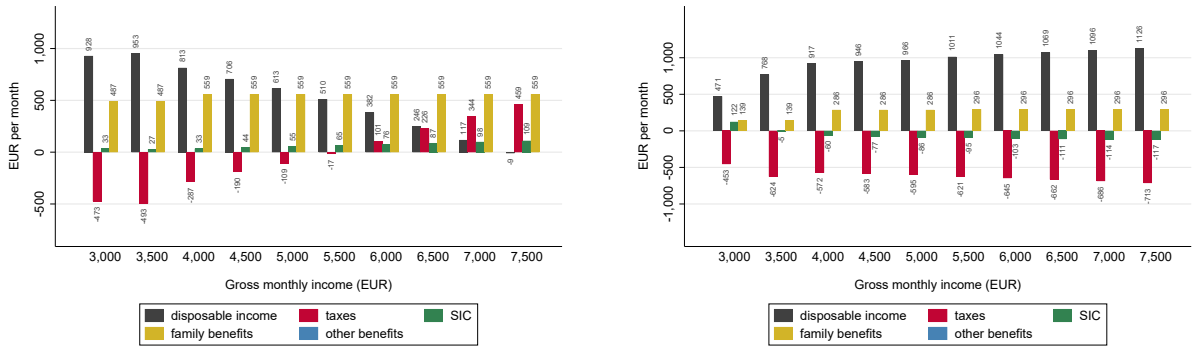
family transfers provided by Luxembourg and those provided by France for a single-parent scenario. Single-parent households receive relatively large transfers linked to the presence of dependent children, therefore, family benefits represent an important component for these households. As earnings increase, the exemption-with-progression mechanism feeds Luxembourg earnings into the marginal rate applied to any French-source income, gradually eroding the tax advantage. The tax advantage disappears beyond EUR 6,000 of gross monthly earnings, where the cross-border worker faces slightly higher tax liabilities than the domestic worker. This mechanism offsets most of the gain from higher family benefits. The net cross-border premium falls below EUR 250 by EUR 6,500, turning marginally negative at EUR 7,500.

The cross-border premium for Belgian residents increases steadily from EUR 471 at EUR 3,000 to EUR 1,126 at EUR 7,500 (EUR 5,775 of disposable income compared with EUR 4,649 under domestic employment). The dominant driver of this advantage is the lower tax liabilities in Luxembourg across the entire distribution. The exemption-without-progression in Belgium keeps Luxembourg earnings out of the Belgian tax schedule. As earnings increase, this mechanism prevents any attenuation of the Luxembourg tax advantage. Luxembourg employment is associated with higher family benefits than those received under the Belgian system. In the absence of an attenuation mechanism, the cross-border premium persists and widens across the earnings distribution.

Other benefits, which includes means-tested social assistance, play only a limited role in explaining the observed disposable income differences. These benefits have a relevant contribution in the lowest income levels but it declines rapidly as earnings increase.

The contrast between France and Belgium for single parents extends the structural pattern identified for singles without children. There is a clear advantage of the French over the Belgian system with respect to family benefits. The first allocates higher benefits for every level of income compared to the later. Meanwhile, the exemption-with-progression in France, operates as an attenuation mechanism, overcoming both the Luxembourg tax advantage and the family benefit gain. However, This attenuation operates gradually an gross earnings increases. At the bottom of the distribution, where the Luxembourg tax advantage is largest, the combined cross-border premium is larger than for singles without children. As earnings rises, family benefits temporarily sustain the premium before the tax reversal eventually dominates at the top, eroding the benefit advantage. In Belgium, in the absence of attenuation, both policy instruments reinforce each other throughout the earnings distribution, resulting in a premium that is larger in absolute terms and more persistent throughout the distribution when compared to singles without children.

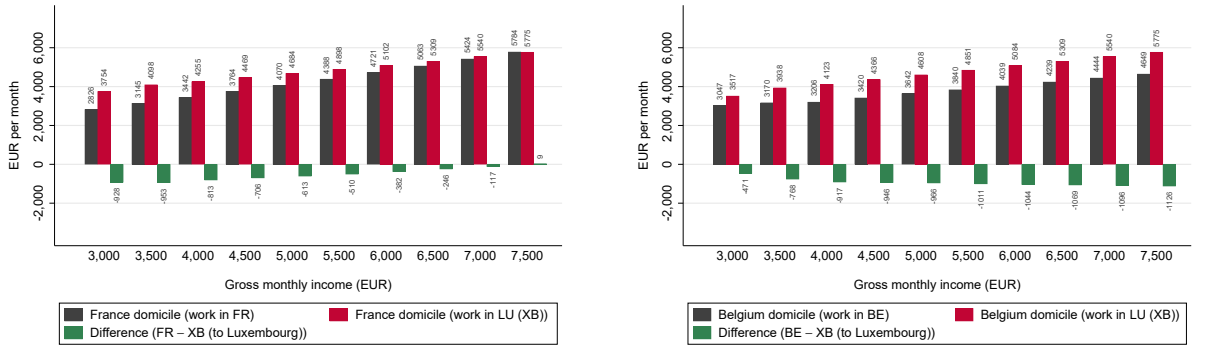
Figure 5: Decomposition of disposable income differences between single-parent cross-border households residing in France and Belgium and households where the parent works in the country of residence.



(a) France

(b) Belgium

Figure 6: Disposable income comparison for single-parent cross-border households residing in France and Belgium versus households where the parent works in the country of residence.



(a) France

(b) Belgium

Residence Effects

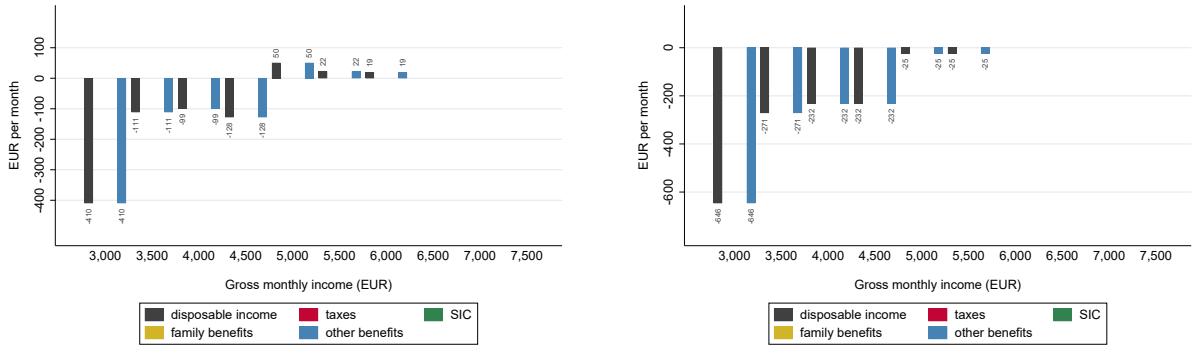
Figure 7a and Figure 7b decompose the disposable income difference between cross-border single-parent households and Luxembourg residents, while Figure 8a and Figure 8b show the respective income levels.

Residence matters for single parents. The gap is concentrated at the bottom of the earnings distribution and narrows quickly as income increases. Since the cross-border earner is taxed under Luxembourg rules in both scenarios, the tax mechanism is absent from the residence effect and the gap is driven by residence-based means-tested transfers. Luxembourg residents at low earnings levels receive benefits such as the social inclusion income (REVIS) and the cost-of-living allowance, while cross-border households receive the equivalent transfers from their country of residence. The narrowing of the gap as earnings increase reflects the phase-out of these income-tested benefits in all three countries. Once households exceed the means-tested threshold, the remaining tax-benefit elements depend on the workplace, and disposable income converges.

For French cross-border households, the gap with Luxembourg residents is about EUR 410 per month at EUR 3,000. It reduces sharply to around EUR 100 between EUR 3,500 and EUR 4,500 and approaches zero in the upper half of the distribution, briefly reversing between EUR 5,000 and EUR 6,000 where the cross-border household has a small advantage of EUR 20 to EUR 50. For Belgian cross-border households, the initial gap is larger at EUR 646 per month and reduces more slowly: it remains around EUR 230 to EUR 270 between EUR 3,500 and EUR 4,500, drops to around EUR 25 between EUR 5,000 and EUR 5,500, and disappears from EUR 6,000 onwards. At the lowest earnings levels, the Belgian system offers smaller means-tested support to working single parents than the French system, which explains why the initial gap with Luxembourg residents is wider for Belgian than for French residents.

The presence of a residence effect for this household type, in contrast to its near-total absence for singles without children, confirms the mechanism identified in the previous subsection: any residence effect must originate from family benefits or means-tested transfers, not from differences in the taxation of labour income. For single-parent households, it is the means-tested transfer channel that is active, and it dissipates quickly with earnings once households rise above the income-tested threshold.

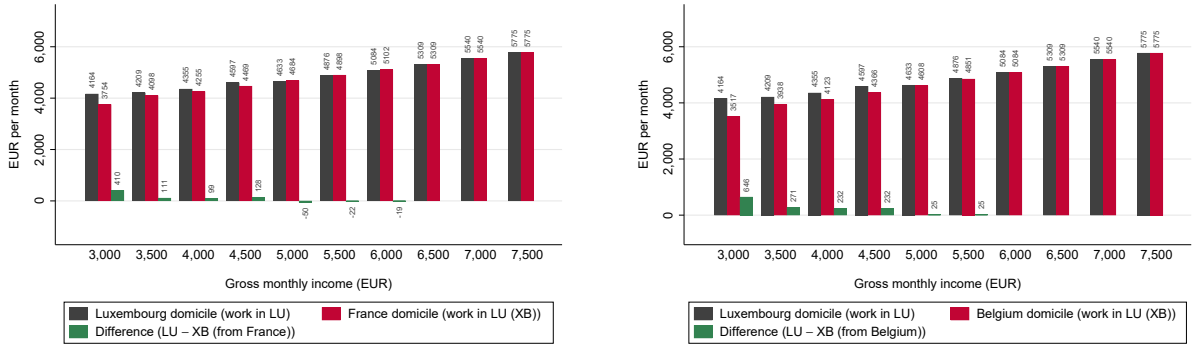
Figure 7: Decomposition of disposable income differences between single-parent cross-border households and Luxembourg resident households.



(a) France

(b) Belgium

Figure 8: Disposable income comparison for single-parent cross-border households versus households residing and working in Luxembourg.



(a) France residence vs Luxembourg residence

(b) Belgium residence vs Luxembourg residence

Measurement Bias

For single-parent households, the workplace effect determines the bias and the residence-country contribution now operates through two channels simultaneously. The tax channel generates the same asymmetric pattern as for singles without children: the bias grows monotonically for Belgian residents, where no attenuation operates, and attenuates with earnings for French residents, where the exemption-with-progression compresses the tax component at higher earnings. The family benefit channel adds a further component reflecting the gap between Luxembourg family transfers and those of the residence country. This component is relatively stable across the distribution and shifts the total bias upward compared with the childless case.

The combined bias has the two features previously identified for singles without children case, compounded by family benefits. First, the bias remains asymmetric across residence countries. It is larger and grows monotonically for Belgian residents, where both channels accumulate without attenuation. Meanwhile, it is earnings-dependent for French residents, where progression eventually reduces the total bias close to zero at the top of the distribution. Second, the family benefit channel contributes a stable component to the bias that is present at all earnings levels, but particularly large at the bottom of the distribution. This establishes the pattern against which to assess the bias for two-earner households, where a joint taxation channel further compounds these effects.

4.3 Two-earner households with children

The simulated household consists of two adults and two dependent children. One adult works in the country of residence with a fixed gross monthly income of EUR 3,000, while the second adult works in Luxembourg as a cross-border commuter. Compared to the two previous household types, a two-earner household adds a third institutional channel: the interaction between joint household taxation in the residence country and the separate taxation of the cross-border earner under the Luxembourg rules. For French residents, this channel operates through the quotient familial, which pools both earners' incomes to determine the household tax liability. For Belgian residents, it operates through the individual taxation of labour income, which limits any household-level tax relief.

Workplace Effect

Figure 9a and Figure 9b decompose disposable income differences between cross-border and domestic employment into its tax, social insurance contribution, family benefit, and other benefit components, separately for French and Belgian residents. Figure 10a and Figure 10b show the corresponding disposable income levels behind these differences.

The cross-border premium for French residents reaches EUR 888 per month at the lowest earnings level evaluated (EUR 5,707 of disposable income compared with EUR 4,819 under domestic employment). However, along the gross earning distribution, the premium displays a non-monotonic pattern driven by the tax mechanism. The tax advantage is largest at the bottom, where the Luxembourg income of the cross-border worker is taxed under the Luxembourg rules and not pooled with the resident spouse under the quotient familial. With higher earnings, the exemption-with-progression erodes the household-level tax advantage progressively as in the previous scenarios. The tax advantage vanishes beyond EUR 6,500 of gross monthly earnings, with the cross-border worker paying slightly more tax than under domestic employment at the top of the earnings range. Meanwhile, the income from family benefits contribute around EUR 559 across most of the distribution, but it rises to EUR 633 from EUR 6,000 gross earnings onwards. This stability produces a partial recovery of the premium in the middle of the distribution. In comparison, social insurance contributions increases steadily from EUR 21 at the bottom to EUR 109 at the top. Overall, the net cross-border premium declines from EUR 888 to around EUR 520 at EUR 5,000, increases slightly to EUR 576 at EUR 6,000, and declines further to EUR 476 at EUR 7,500.

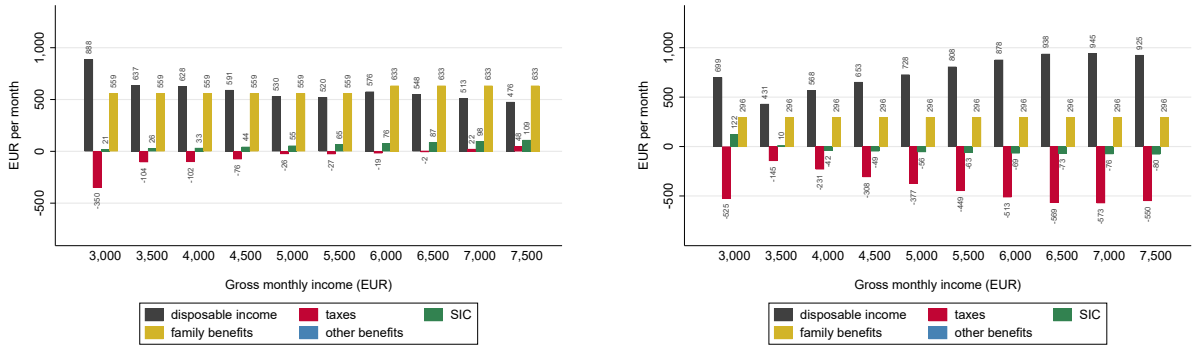
The cross-border premium for Belgian residents grows monotonically. Besides the dip of EUR 431 at EUR 3,500, it grows from EUR 699 at EUR 3,000 to EUR 945 at EUR 7,000. For cross-border workers with EUR 7,500 in gross earnings, the premium declines slightly to EUR 925 (EUR 7,853 of disposable income compared with EUR 6,927 under domestic employment). Similarly to the French resident cross-border worker, the tax advantage is the dominant driver. In contrast, this advantage increases with earnings, reflecting Belgium's exemption-without-progression. Luxembourg earnings do not feed into the Belgian tax schedule, and the individual taxation eliminates any household-level pooling effect through which the cross-border earner's income could affect the resident spouse's tax liability. Consequently, the gap between Luxembourg's tax on the cross-border earner and the Belgian tax that would apply under domestic employment increases with earnings without attenuation. Family benefits contribute around EUR 296.

Other benefits, including means-tested social assistance, play a smaller role overall. Their importance is concentrated at lower income levels, where households may still qualify for income-tested transfers. Increases in labour income or changes in the tax system can lead to reductions in benefit eligibility, partially offsetting gains from cross-border employment.

The contrast between France and Belgium for two-earner households is consistent with the structural pattern identified in the two simpler household types. The exemption-with-progression mechanism in France creates an attenuation that operates through both earners: the cross-border earner's Luxembourg income feeds into the marginal rate on the resident spouse's French income, compressing the household-level tax advantage more rapidly than in the single-earner cases. In Belgium, the combination of exemption-

without-progression and individual taxation removes both the direct progression and the indirect household pooling effect, widening the Luxembourg tax advantage with earnings without attenuation.

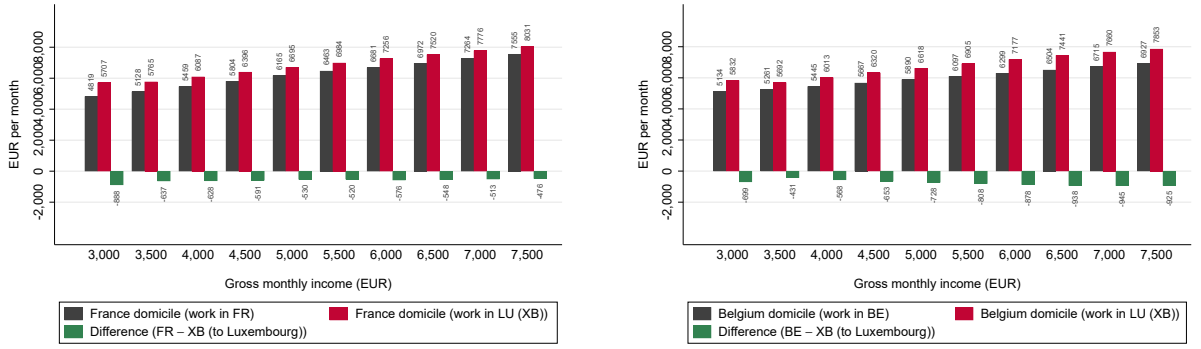
Figure 9: Decomposition of disposable income differences between cross-border households residing in France and Belgium and households where both partners work in the country of residence.



(a) France

(b) Belgium

Figure 10: Disposable income comparison for cross-border households residing in France and Belgium versus households where both partners work in the country of residence.



(a) France

(b) Belgium

Residence Effects

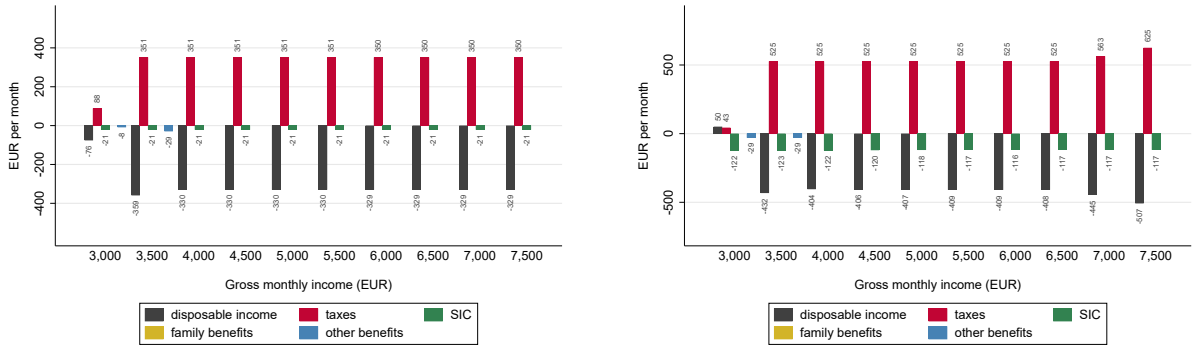
Figure 11a and Figure 11b decompose the disposable income difference between cross-border two-earner households and Luxembourg residents. Figure 12a and Figure 12b show the corresponding income levels.

Institutional differences persist for this household type even when the workplace is Luxembourg, and the mechanism is qualitatively different from the single-parent case. In these comparisons, the main drivers of income differences are residence-based taxes. Households residing in Luxembourg are subject to Luxembourg tax rules for all income sources and benefit from joint household taxation applied to both earners' combined income. By contrast, cross-border households remain partly integrated into the tax-benefit system of their country of residence: the cross-border earner is taxed under Luxembourg rules individually, while the resident spouse is taxed under the rules of the country of residence. As a result, disposable income differences arise even when labour income and workplace are identical.

For French cross-border households, the gap with Luxembourg residents is small at EUR 3,000 (around EUR 76 per month in favour of Luxembourg residents) and widens to around EUR 330 from EUR 3,500 onwards, where it stabilises. Social insurance contributions act in the opposite direction, partially offsetting the tax disadvantage throughout the distribution. For Belgian cross-border households, the

gap is small and positive at EUR 3,000, where Belgian cross-border households have about EUR 50 more disposable income than Luxembourg residents, driven by lower Belgian social insurance contributions on the resident spouse's income. This advantage reverses sharply from EUR 3,500 onwards: the gap in favour of Luxembourg residents jumps to around EUR 400 and grows steadily to EUR 507 at EUR 7,500. The growing gap for Belgian residents reflects the progressive widening of the joint taxation advantage as the cross-border earner's income rises, compounded by the absence of household-level pooling in the Belgian individual taxation system.

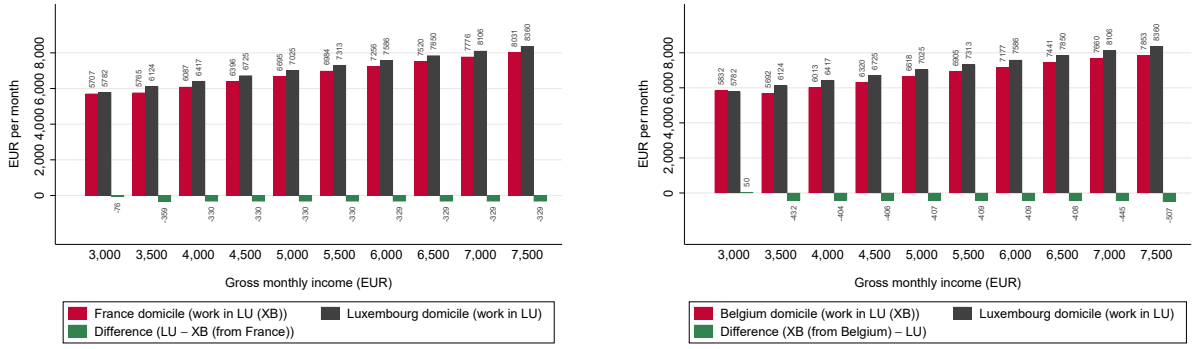
Figure 11: Decomposition of disposable income differences between cross-border households and Luxembourg resident households.



(a) France

(b) Belgium

Figure 12: Disposable income comparison for cross-border households versus households residing and working in Luxembourg.



(a) France residence vs Luxembourg residence

(b) Belgium residence vs Luxembourg residence

The residence effect for two-earner households is structurally distinct from the single-parent case due to taxation. The gap does not dissipate with earnings, but persists or grows across the distribution. This persistence shows that for two-earner households, the residence effect compounds the workplace effect at higher earnings: both components of the measurement bias remain active across the full earnings range.

Measurement Bias

For two-earner households with children, simulating cross-border workers under residence-country rules misrepresents their disposable income through three channels. The tax channel and the family benefit channel operate as in the single-parent case, generating the same asymmetric and earnings-dependent pattern across residence countries. The joint taxation channel adds a third component that is absent in the single-earner household types: by applying the residence-country household tax schedule to the

cross-border earner's Luxembourg income, the model incorrectly pools that income with the resident spouse's earnings under either the quotient familial in France or the Belgian individual tax schedule, whereas the correct simulation taxes the two earners separately under their respective country rules.

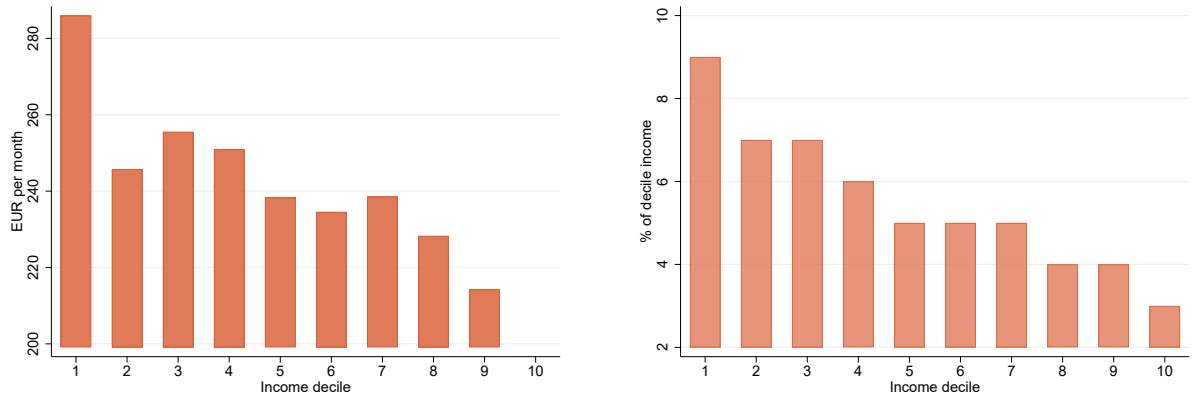
The bias has the same two features identified in the simpler household types, compounded by an additional persistent component. First, it is uneven across countries of residence: larger and increasing for Belgian residents, for whom no attenuation operates via any of the three channels, and more compressed for French residents, for whom the exemption-with-progression reduces the tax component at higher earnings. Second, comparing to single-parents, the bias does not vanish at the top of the distribution in either country, because joint taxation persists throughout the earnings range. This bias can affect both the distribution of disposable income and the evaluation of policy reforms in border regions. This bias is especially important since the two-earner households with children represent the largest share of Luxembourg's cross-border workers.

4.4 Distributional implications of cross-border modelling

In this section, we conduct a simplified weighted simulation of the Luxembourg workforce to illustrate the distributional consequences of disregarding cross-border institutional tax-benefit rules. Cross-border workers from France and Belgium are allocated their simulated disposable incomes under both the correct cross-border rules and the domestic-only counterfactual, and are weighted by their observed share of the Luxembourg workforce (46%) and their composition across household types. Resident workers are allocated an income profile that is approximated using the observed quantile distribution reported in Table A-1.

The findings indicate that applying domestic-only tax rules to cross-border workers consistently underestimates their disposable income across the entire income distribution. As illustrated in Figure 13a, the measurement bias is positive for every income decile, varying in absolute terms from roughly EUR 199 in the highest decile to about EUR 286 in the lowest decile of the overall Luxembourg workforce. In relative terms (Figure 13b), the bias is largest at the bottom of the distribution (about 8% of correctly-modelled disposable income), and declines gradually toward the top. This pattern reflects the progressive structure of the Luxembourg tax system: at lower earnings levels, the tax advantage of Luxembourg employment accounts for a larger share of total disposable income. The bias is largest for households with children, where family benefit coordination rules interact with taxation, and smallest for single individuals without children, where family-related transfers play no role.

Figure 13: Measurement bias by income decile in the full Luxembourg workforce



(a) Absolute bias (EUR per month)

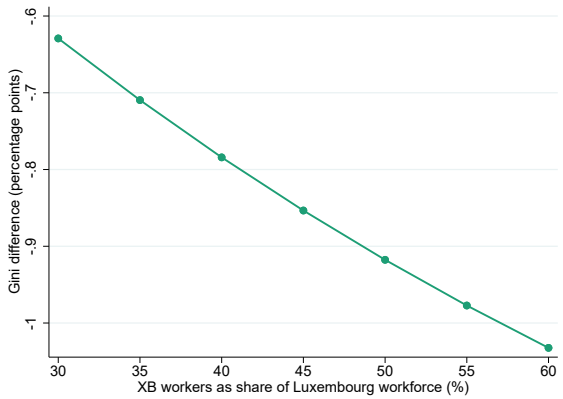
(b) Relative bias (% of disposable income)

Note: Positive values indicate that domestic-only modelling underestimates disposable income. Weights: single 33%, single parent 17%, couple with children 50%. Country weights: France 70%, Belgium 30% (normalised, Germany excluded). Resident income approximated from Table A-1.

For the entire Luxembourg workforce, domestic-only modelling produces a Gini coefficient of 11.8, compared with 10.9 when cross-border situations are correctly modelled (a gap of 0.87 percentage points). The sign of this bias is important: since income is most underestimated for cross-border households who gain the most from Luxembourg's relatively low effective tax rates, domestic-only modelling compresses the top end of the income distribution and thus substantially overestimates the degree of income equality. Restricting the analysis to cross-border workers, the distortion is even more pronounced: the Gini increases from 7.8 under correct modelling to 9.1 when using domestic-only assumptions, a difference of 1.35 percentage points.

The magnitude of this distortion increases proportionally with the share of cross-border workers, as shown in Figure 14. At a cross-border share of 30% the Gini difference amounts to 0.63 percentage points; at 60% it reaches 1.03 percentage points. This sensitivity shows that the modelling error is not a fixed property of the institutional setting, but grows in proportion to the role the cross-border workforce plays in the economy. This is a particularly relevant consideration for Luxembourg, which hosts the largest cross-border workforce in the European Union and within the *Greater Region*.

Figure 14: Sensitivity of the Gini coefficient difference to the cross-border workforce share



Note: Gini difference = Gini(domestic-only model) − Gini(correct model). A positive value indicates that domestic-only modelling overstates income equality. Gini difference at 30% XB share: 0.63 pp; at 46% (observed): 0.87 pp; at 60%: 1.03 pp. Household type and country weights as in Table A-1.

These results provide the order-of-magnitude approximations and should not be interpreted as precise distributional findings. The simulation is based on stylised household types and a parametric approximation of the resident income distribution, and does not use micro data. The direction of the bias, domestic-only modelling systematically underestimates disposable income and overstates income equality, is robust across calibration assumptions. The precise magnitude, however, is sensitive to the assumed household type composition and country weights. The paper's core contribution is therefore the identification of the institutional channels and the direction of the bias; a precise estimate of its magnitude requires representative micro data linking household composition, gross income, and cross-border status, which remains an important avenue for future research.

Beyond the magnitude of the estimated bias, the results have broader implications for the measurement of inequality in integrated cross-border labour markets. Conventional inequality analysis typically assumes that labour market participation, taxation, social insurance contributions and benefit entitlement are governed by a single national institutional framework. Our findings demonstrate that this assumption may lead to systematic measurement error in regions where employment, taxation and social protection are distributed across multiple jurisdictions. As labour markets become more integrated across national borders, and welfare institutions remain nationally organised, measured income distributions may diverge from the actual distribution of disposable resources available to households within the same functional economic region. The contribution of this paper is therefore not only to quantify the disposable income

consequences of cross-border work, but also to demonstrate how incorporating cross-border institutional arrangements into microsimulation models can improve the measurement of inequality and redistribution in cross-border regions.

5 Conclusion

This paper examined how cross-border employment influences disposable income within integrated labour markets characterised by nationally fragmented welfare systems. Focusing on the Luxembourg-Belgium-France segment of the *Greater Region* , we show that households participating in a common labour market may nonetheless experience substantially different disposable income outcomes due to the interaction of national tax-benefit systems, social insurance arrangements, and EU coordination rules. While labour market integration has intensified across European border regions, welfare analysis remains predominantly bounded by national institutional frameworks. This creates an important analytical challenge when workers reside in one country while earning income and contributing to social protection in another one.

To address this gap, we develop a modelling infrastructure that runs country-specific EUROMOD models in parallel and combines residence-country and workplace-country tax-benefit rules in order to simulate household disposable income under more realistic institutional arrangements that cross-border workers face. Using hypothetical household scenarios for France, Belgium and Luxembourg, we demonstrated that standard residence-based modelling can generate systematic distortions in the measurement of disposable income when cross-border institutional coordination is ignored. Our results show that these distortions arise through three principal channels: income taxation, social insurance contributions, and the coordination of family benefits.

Our findings highlight substantial heterogeneity in the disposable-income of cross-border employment across household types and countries of residence. For single individuals without children, differences are driven almost exclusively by taxation. Nonetheless, differences remain relatively modest, particularly when compared with Luxembourg residents. In contrast, for households with children, cross-border institutional interactions become considerably more important. Family benefit coordination rules and differential tax treatment generate large distortions to the disposable-income estimations, particularly at lower and middle income levels. The contrast between France and Belgium illustrates how residence-country institutions shape the magnitude and persistence of this bias. In France, the exemption-with-progression mechanism compresses the disposable-income advantage of Luxembourg employment at higher earnings levels, while in Belgium the absence of tax progression linked to foreign income allows the cross-border premium to persist more strongly across the income distribution.

Beyond the institutional analysis, the paper demonstrates that ignoring cross-border tax-benefit coordination can lead to meaningful measurement bias in distributional analysis. Our stylised simulation suggests that modelling cross-border workers solely under residence-country rules systematically underestimates disposable income, particularly in the lower part of the income distribution and among households with children. These findings imply that conventional microsimulation approaches may misrepresent levels of redistribution, poverty risks, and inequality in highly integrated cross-border labour markets.

Our paper illustrates the need for microsimulation frameworks to better accommodate institutional interactions that extend across national boundaries in cross-border labour markets. Additionally, it highlights how functional labour market integration can coexist with fragmented welfare systems, creating distributional outcomes that depend jointly on the country of residence, the place of employment, and the institutional architecture coordinating taxation and social protection.

Several limitations should be acknowledged. First, the analysis is based on hypothetical household scenarios and therefore isolates institutional mechanisms without capturing behavioural responses, working from home or population heterogeneity inherent in observed household micro-data. Second, the simulations are static and do not account for labour supply responses, migration decisions, or longer-term life-cycle

effects. Third, the distributional exercise relies on simplified assumptions regarding household composition and workforce structure. Future research could extend the framework to representative micro-data and incorporate behavioural modelling in order to assess the aggregate distributional consequences of cross-border work more comprehensively across European border regions.

Our paper demonstrates that the measurement of disposable income and inequality cannot be fully understood within nationally bounded frameworks when labour markets operate across borders. The challenge for regional analysis is therefore not only to understand cross-border labour mobility, but also to develop measurement frameworks capable of capturing redistribution across overlapping institutional spaces.

Beyond measurement, our findings carry broader implications for the territorial organisation of cross-border regions. The institutional fragmentation documented here is not merely a modelling problem: it reflects a structural feature of integrated labour markets in which fiscal sovereignty remains nationally bounded. Luxembourg's tax base depends on a workforce that resides outside its territory and consumes public services in France, Belgium, and Germany, while those residence countries provide services to workers whose fiscal contributions flow elsewhere. This asymmetry has long been recognised qualitatively (Lamour, 2020), but the household-level decomposition developed in this paper makes it possible to trace precisely how it operates through the channels of income taxation, social insurance, and family benefit coordination. As the European Commission's cross-border governance agenda advances, including efforts to remove fiscal and administrative obstacles in border regions, tools capable of quantifying these distributional interactions across institutional boundaries will be essential for designing equitable and evidence-based policy responses.

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AI Statement

Generative AI (Claude) was used for drafting, editing and grammar checking.

A Appendix

Table A-1: Descriptive statistics of labor force in Luxembourg in 2021: Cross-border workers by country of residence; and local workers by nativity status

Characteristic	Belgium	France	Germany	Total	Native-born	Foreign-born	Total (%)
Total (%)	23.0	52.9	24.3	100	41.2	58.8	100
Age (mean)	41.5	40.2	43.8	41.4	44.8	43.1	43.8
	(0.6)	(0.3)	(0.7)	(0.1)	(0.6)	(0.5)	(0.3)
Household size (mean)	2.8	2.7	2.5	2.7	2.6	2.8	2.7
	(0.1)	(0.1)	(0.1)	(0.0)	(0.1)	(0.1)	(0.0)
Male (%)	68.0	61.3	63.9	63.6	55.1	66.6	61.9
	(2.1)	(1.3)	(1.8)	(1.0)	(2.5)	(2.3)	(1.7)
Residing in country of birth (%)	83.2	89.1	80.4	85.8	100.0	0.0	41.2
	(2.4)	(1.4)	(2.4)	(1.1)	(0.0)	(0.0)	(1.5)
Marital status (%)							
Single	31.3	33.3	35.4	33.2	36.4	35.7	36.0
	(3.1)	(2.2)	(3.1)	(1.4)	(2.3)	(2.2)	(1.5)
Couple	57.7	55.1	54.9	55.7	48.0	53.9	51.5
	(3.2)	(2.3)	(3.1)	(1.6)	(2.5)	(2.2)	(1.5)
Divorced	10.6	10.9	9.4	10.5	13.3	9.6	11.1
	(2.0)	(1.4)	(1.9)	(1.0)	(1.8)	(1.5)	(1.2)
Widowed	0.5	0.7	0.3	0.6	2.3	0.9	1.5
	(0.4)	(0.4)	(0.3)	(0.3)	(0.9)	(0.4)	(0.4)
Level of education (%)							
Low	5.9	3.0	18.3	7.4	13.8	20.2	17.6
	(1.7)	(0.9)	(2.7)	(0.9)	(2.0)	(2.3)	(1.6)
Middle	23.6	34.3	37.3	32.5	44.6	20.5	30.4
	(3.0)	(2.2)	(3.3)	(1.5)	(2.6)	(2.2)	(1.7)
High	70.5	62.7	44.4	60.1	41.6	59.3	52.0
	(3.1)	(2.2)	(3.2)	(1.5)	(2.4)	(2.4)	(1.7)
Median Gross Income (thousands euros)							
All households	93.0	71.9	97.6	83.0	131.2	112.6	120.3
	(3.2)	(1.7)	(4.0)	(1.4)	(5.4)	(4.2)	(3.3)
Bottom 20%	35.4	26.7	37.3	30.3	35.8	28.8	31.8
	(1.8)	(1.1)	(1.7)	(0.9)	(2.3)	(1.8)	(1.2)
Next 20%	60.5	45.3	59.4	51.2	71.8	58.9	64.2
	(0.9)	(0.8)	(1.4)	(0.5)	(2.3)	(1.3)	(1.6)
Middle 20%	79.7	62.0	79.7	70.5	106.6	86.5	94.7
	(1.2)	(0.9)	(1.2)	(0.6)	(2.6)	(1.8)	(1.6)
Next 20%	106.5	84.6	106.7	95.4	155.1	128.0	139.4
	(2.2)	(0.9)	(2.0)	(0.9)	(3.0)	(1.8)	(1.7)
Top 20%	185.0	142.4	206.7	169.8	290.0	263.1	273.7
	(6.2)	(2.8)	(8.8)	(3.2)	(15.5)	(10.6)	(8.9)

Source: Matha et al. (2024) from the Cross-border and Resident Household Finance and Consumption Survey - wave 4

Table A-2: Distribution of Number of Children by Marital Status (%)

Cross-border workers				
Civil status	Kids 0	Kids 1	Kids 2	Kids 3+
Single	54.30	18.63	23.74	3.33
Couple	42.46	20.32	28.41	8.80
Divorced	68.79	22.03	8.70	0.49
Widowed	30.27	0.00	69.73	0.00
Total	48.62	19.72	25.51	6.15

Residents				
Civil status	Kids 0	Kids 1	Kids 2	Kids 3+
Single	67.74	20.85	6.36	5.05
Couple	56.24	21.39	14.70	7.67
Divorced	73.95	18.27	6.94	0.84
Widowed	86.49	5.24	7.94	0.33
Total	62.88	20.38	10.82	5.91

Source: Authors' calculations using the Cross-border and Resident Household Finance and Consumption Survey - wave 4